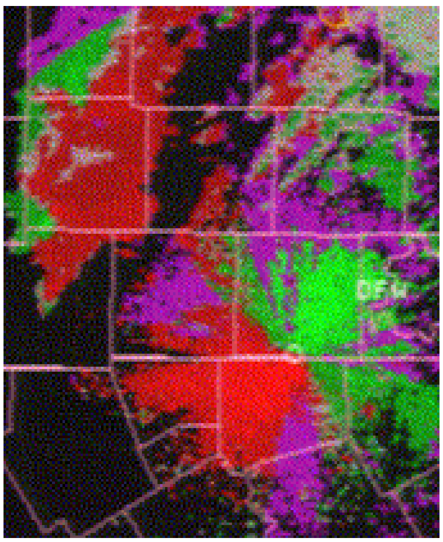
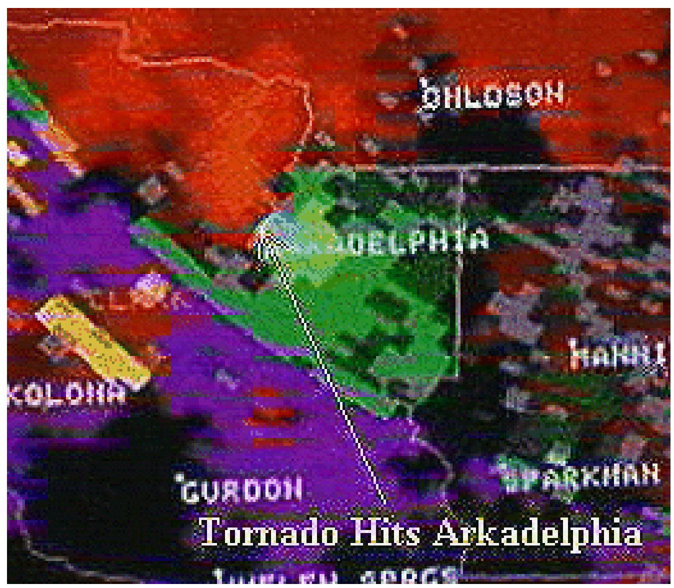
Distance Learning Operations Course





IC 5.4: Base Products and Velocity Interpretation

Presented by the Warning Decision Training Branch

Version: 0208

Lesson 1: Base Products

Overview

Review from Radar Principles

Analog data are sent from Receiver to Signal Processor.

Analog data are converted to digital base data at the Signal Processor.

Clutter suppression and range unfolding are completed.

Base data sent to RPG through wideband.

After velocity dealiasing by RPG, product generation occurs.

Why use Base Products?

Base radar data are preferred for analyzing significant meteorological features, which may be less apparent in the derived products.

The products can be used to determine significant synoptic and mesoscale features, such as fronts and other boundaries, weak echo regions, and heavy snow bands.

Investigate Base Products to verify Derived Product features. When you look at a Base Product, you are seeing the data used as input for all the derived products, and can use this data to evaluate the derived products. For example, is that heavy precipitation area on the Three Hour Precipitation Product from rain, or from the bright band? At what altitude is the higher reflectivity occurring on the Composite Reflectivity?

Objectives

Upon completion of this lesson, without references and according to standardized instruction, you will be able to:

1. Identify specific characteristics of any Base Product.
2. Identify limitations of any Base Product.
3. Identify specific applications of any Base Product.

Base Product Characteristics

Base Products are Generated at the RPG

1. When they are included in the Generation List at the RPG Human Computer Interface (HCI).

2. When they are included in the RPS List of Associated Users.

3. When a one time request is made by an Associated User.

4. When they are alert paired products.

All Base Products

All base products are displayed as a polar coordinate (360° azimuth) color image, 1° beamwidth by one of three resolutions available.

Base products will be displayed with the best resolution available in the database. For example, if all three resolutions of base velocity are in the database, a composited velocity product will be displayed using the 0.13 nm resolution to 32 nm, the 0.27 nm resolution from 32-62 nm, and the 0.54 nm resolution from 62-124 nm. The exceptions are the 8-bit Digital Base Products. The 8-bit Base Velocity displays the 0.13 nm resolution to 124 nm, and the 8-bit Base Reflectivity displays the 0.54 nm resolution to 248 nm.

Base Products are relative to the RDA. The beam always originates from the RDA and not the location of the operator, or the RPG.

The products are available for any elevation angle of the current VCP in effect. If the radar is in VCP 11, Base Products are available for all 14 elevation angles. If VCP 31 is current, then only 5 elevation angles are available.

The Base Products

Base Reflectivity

Generation

The best resolution for base reflectivity products is 0.54 nm. This is representative of a 0.54 nm by 1° volume of the atmosphere. In order to generate this data, the power from four successive 0.13 nm bins is averaged. This average power is then converted to dBZs at the RDA. After the base data is created, it is transmitted to the RPG via the wideband link.

Characteristics

R product legend description:

- RPG ID: kxxx
- ELEVATION ANGLE: x.x in degrees
- PRODUCT NAME: Reflectivity
- UNITS: dBZ
- DATE: Day of week, time, and date **in UTC**

R product annotations:

- VCP: 11, 21, 31 or 32
- Product Resolution: km
- Max Value: MX xx dBZ

Display Resolutions

The three resolutions and corresponding ranges of Base Reflectivity are 1° beamwidth by

- .54 nm / 1 km - Range 124 nm
- 1.1 nm / 2 km - Range 248 nm
- 2.2 nm / 4 km - Range 248 nm

The 0.54 nm resolution product displays all of the original 0.54 by 1° base data. The 1.1 nm resolution product displays the maximum of two consecutive 0.54 nm data values. The 2.2 nm resolution product displays the maximum of four consecutive

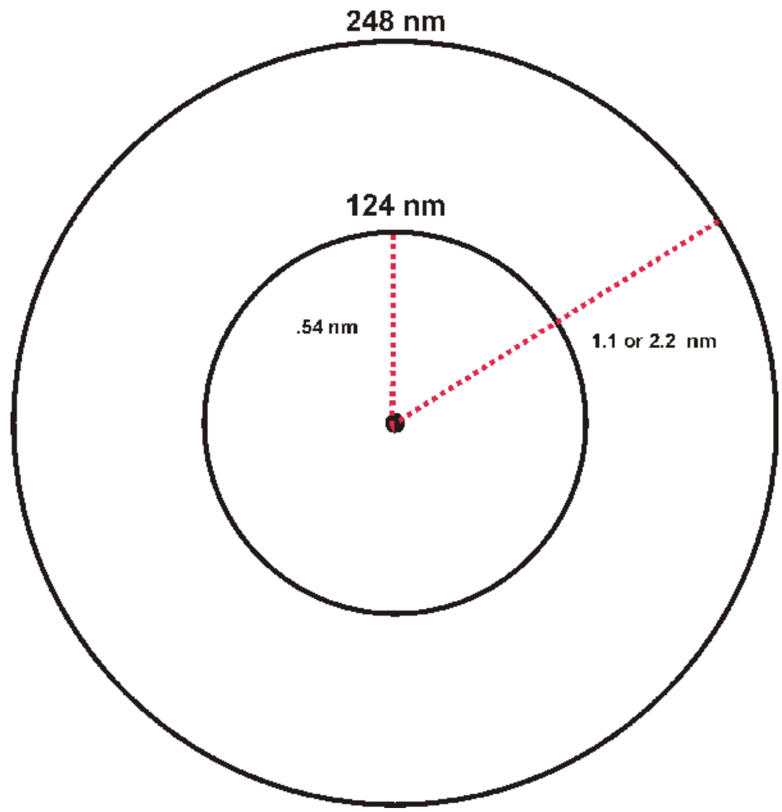


Figure 1-1. Values of reflectivity retained for display on products of different resolutions. Base Reflectivity uses three different resolutions as available in the database.

0.54 nm data values. See Fig. 1-3 for an example of a Base Reflectivity product.

Appearance of echoes

Storms will change appearance when product resolution is changed. This is due to the way the RPG generates different resolution products. Note that

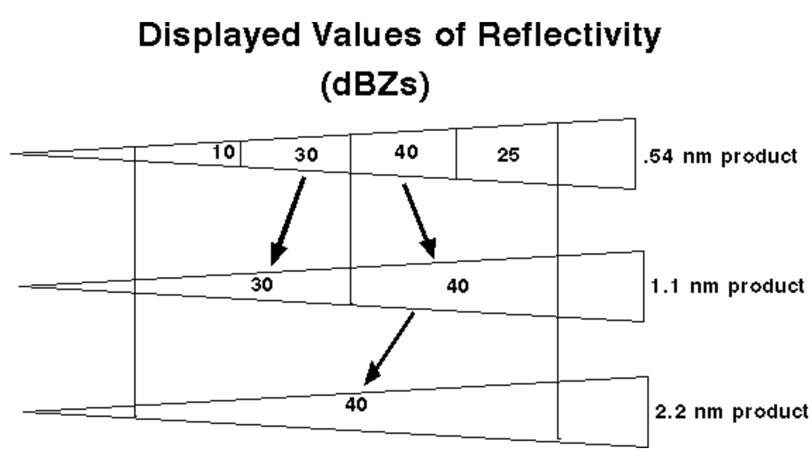


Figure 1-2. Values of reflectivity retained for display on products of different resolutions.

the maximum reflectivity value will always be displayed.

Implications to the operator

The radar operator must take resolution into consideration when interpreting the data displayed on these products. This method of display will have these effects:

Areal coverage of reflectivity will appear larger as resolution goes from 0.54 to 2.2 nm.

Maximum reflectivity is always displayed as resolutions change, preserving important meteorological features (storm cores, etc.).

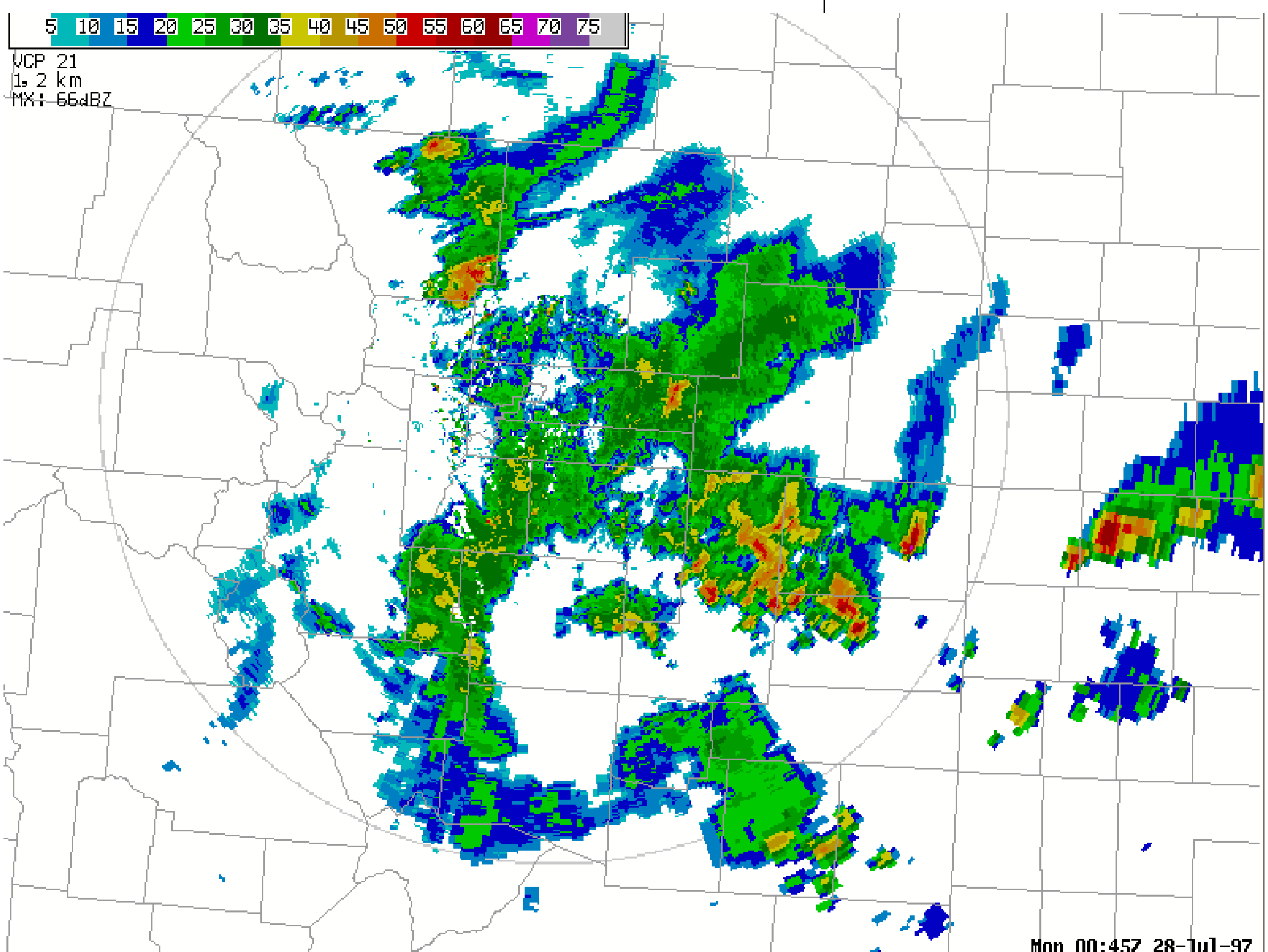


Figure 1-3. Example of displayed resolution differences on a Base Reflectivity product. The 0.54 nm and 1.0 nm resolutions are displayed.

Data Levels

Clear Air Mode (Mode B), VCPs 31 and 32

16 Data Levels range from -28 dBZ to ≥ 28 dBZ
8 Data Levels range from 5 dBZ to ≥ 57 dBZ

Precipitation Mode (Mode A), VCPs 11 and 21

16 Data Levels range from 5 dBZ to ≥ 75 dBZ
8 Data Levels range from 5 dBZ to ≥ 57 dBZ

Note that the data level range of the 8 data level Base Reflectivity product does not change with VCP changes. Only the 16 data level base reflectivity products change data level values with a change from Precipitation Mode to Clear Air Mode, and vice versa. (See Fig. 1-4 for an example of a clear air reflectivity product.)

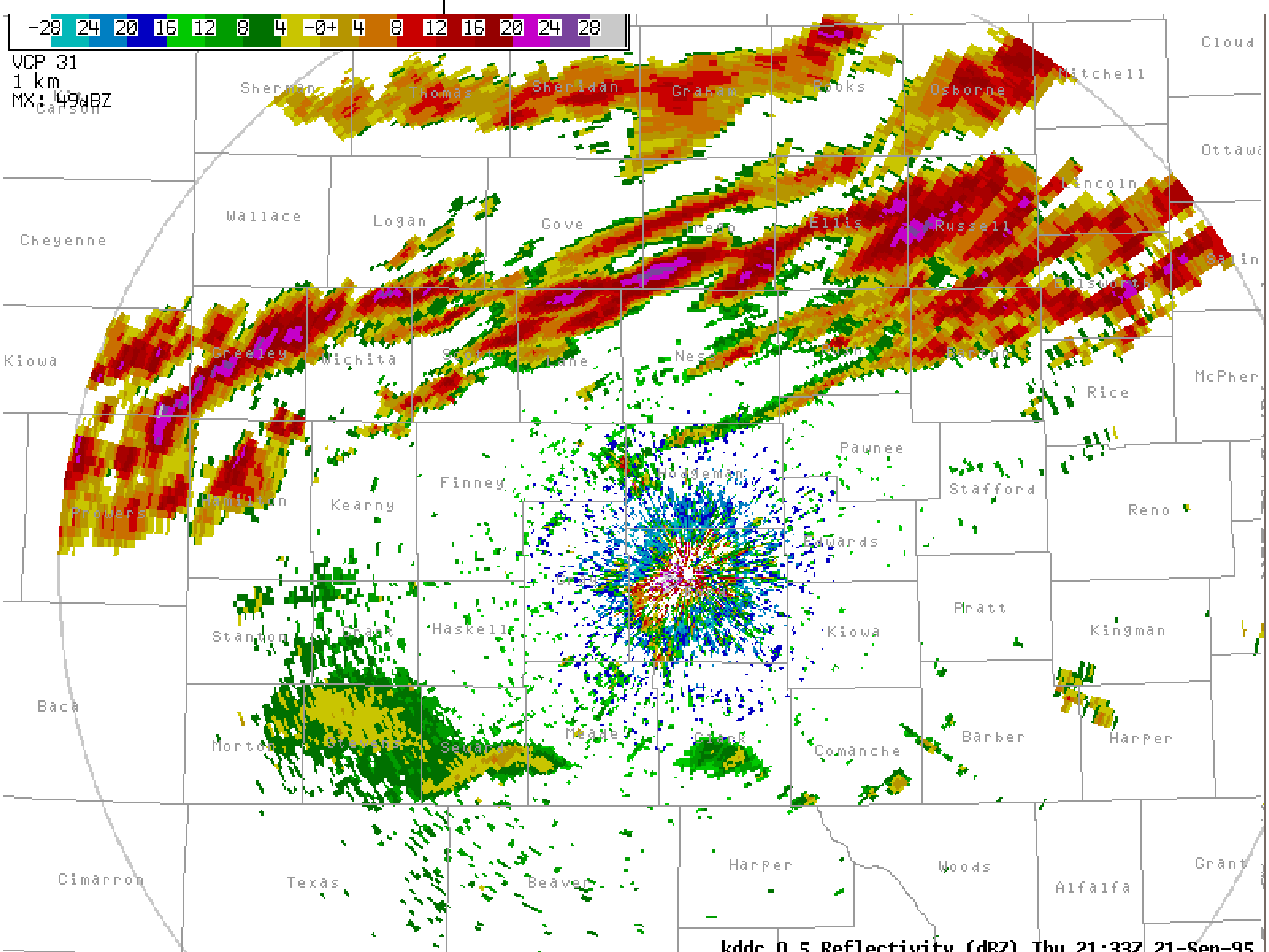


Figure 1-4. Clear Air Mode Reflectivity Product.

Data levels are in dBZ, and are displayed using lower bound thresholds. This means that the numbers beside the color bar in the annotations area of the product are the lowest dBZ values for each color. In Fig. 1-3, the color labeled 35 dBZ can actually range from 35-39 dBZ.

The maximum reflectivity (dBZ) is noted in the product annotation area and may occur anywhere in the product. The location of the maximum reflectivity is not displayed.

There are six unique versions of Base Reflectivity, which are a combination of the 3 different resolutions and two data level sets. The version you display depends on a combination of the resolutions and data levels in your database, and the scale you have selected for viewing.

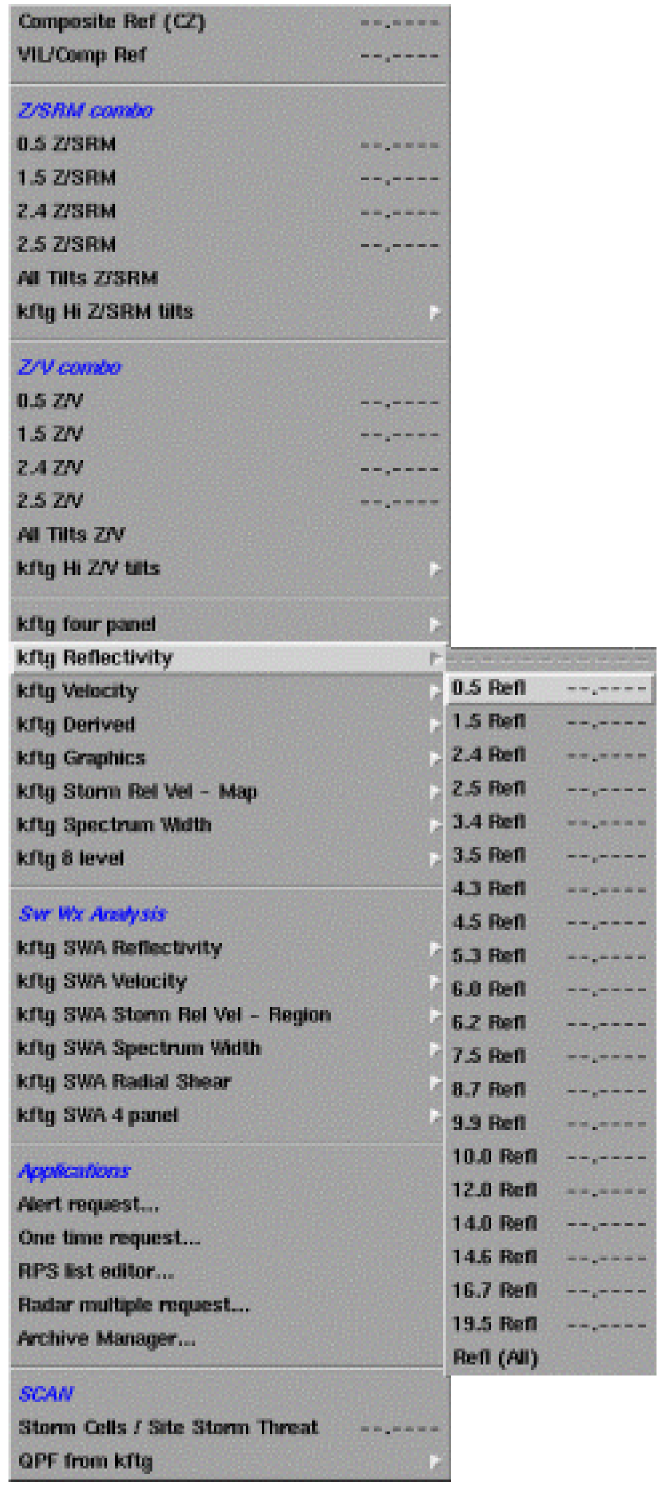


Figure 1-5. Base Reflectivity product menu.

Base Reflectivity Product Limitations

1. Data Level Values

Data level values cannot be adjusted by the radar operator, although the data level values do change with respect to Precipitation and Clear Air Modes.

2. Weak returns not displayed in Precipitation Mode

In Precipitation Mode, the lowest reflectivity displayed is 5 dBZ, which may eliminate some clear air returns from the reflectivity product.

Base Reflectivity Product Strengths

1. Observe precipitation intensity, movement and trends

Base reflectivity has been the standard output from radars for the past 50 years, and still remains one of the most useful outputs from the WSR-88D. Radar operators rely on Base Reflectivity to determine the intensity of echoes, evaluate storm structure, and look for heavy snow bands, for example. Time lapses of Base Reflectivity are an excellent tool for determining the movement of precipitation echoes, as well as the trends. Have the echoes gained or lost intensity? When will the rain begin? When will it end? All are questions that can be answered with the Base Reflectivity product.

2. Weak returns in Clear Air Mode displayed

The 16 data level product displays down to -28 dBZ in clear air mode. This can make the detection of boundaries, light precipitation, or snow more apparent.

3. Observe non-precipitation phenomena

The sensitivity of the WSR-88D allows non-precipitation features such as finelines, clouds, birds, and smoke plumes to be displayed. Some of these may be meteorologically significant, such as locating a focus for initial convection. A loop or using the distance speed tool can help determine the timing of a frontal passage.

8-bit Reflectivity (High Resolution)

Generation

The ***only*** resolution available for the 8-bit Reflectivity is 0.54 nm. This is representative of a 0.54 nm by 1° volume of the atmosphere. In order to generate this data, the power from four successive 0.13 nm bins is averaged. This average power is then converted to dBZs at the RDA. After the base data is created, it is transmitted to the RPG via the wideband link. Unlike the Base Reflectivity product, which only displays 0.54 nm resolution out to 124 nm, the 8-bit Reflectivity displays 0.54 nm resolution out to 248 nm.

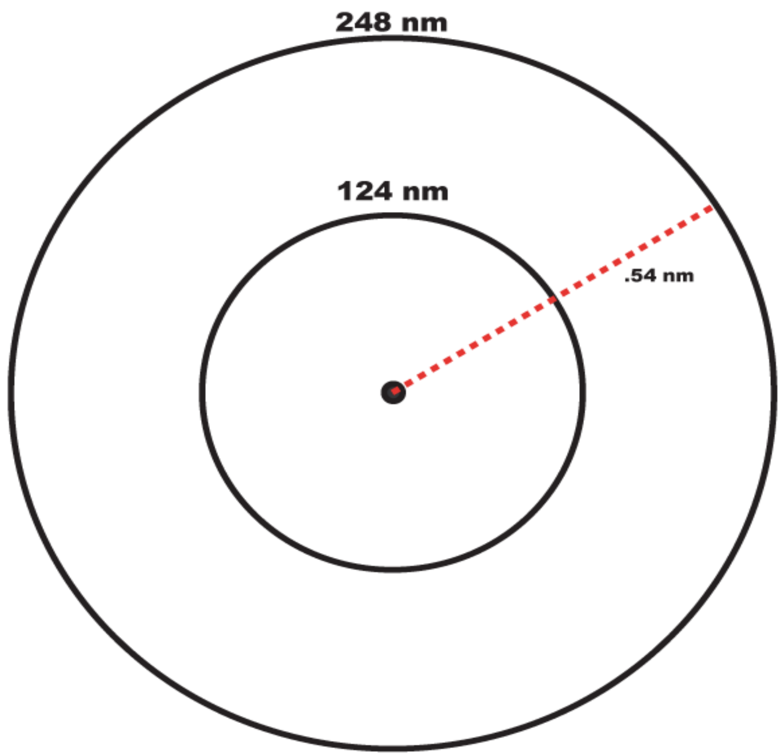


Figure 1-6. 8-bit Reflectivity uses one resolution.

Characteristics

8-bit Ref product legend description:

- RPG ID: kxxx
- ELEVATION ANGLE: x.x in degrees
- PRODUCT NAME: 8-bit Reflectivity
- UNITS: dBZ

- DATE: Day of week, time, and date in UTC

8-bit Ref product annotations:

- VCP: 11, 21, 31 or 32
- Product Resolution: (NA) km
- Max Value: (NA) dBZ

Display Resolution

The only resolution and corresponding range of the 8-bit Reflectivity product is 1° beamwidth by:

- .54 nm / 1 km - Range 248 nm

Appearance of echoes and implications to the operator

The maximum reflectivity value will always be displayed. Storms do not change appearance beyond 124 nm, as they do with the Base Reflectivity, because the resolution remains the same.

Data Levels

Clear Air Mode (Mode B) VCPs 31 and 32

256 Data levels: -30 dBZ to > 90 dBZ

Precipitation Mode (Mode A) VCPs 11 and 21

256 Data levels: -30 dBZ to > 90 dBZ

AWIPS readout is to the nearest 0.5 dBZ

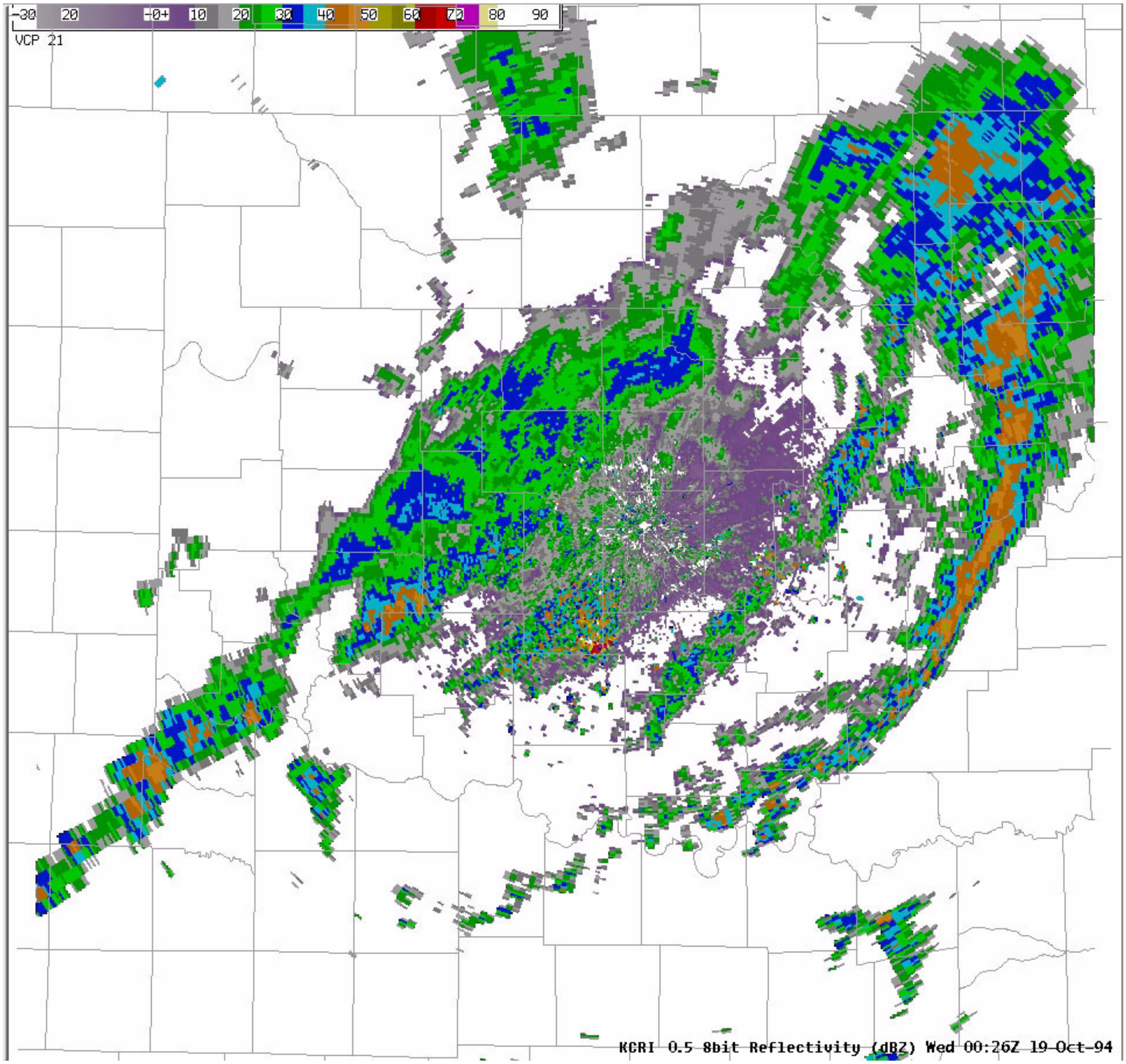


Figure 1-7. This 8-bit Reflectivity product has a maximum range of 248 nm. The resolution is .54 nm out to 248 nm. (.54 nm is the only resolution available for the 8-bit Reflectivity product)

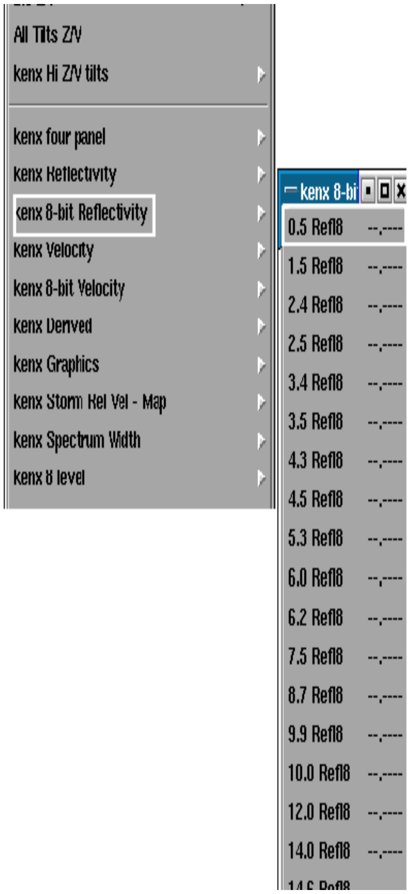


Figure 1-8. 8-bit Reflectivity product menu.

8-bit Reflectivity Product Limitations

1. Data Level Values

Data level values cannot be adjusted by the radar operator.

8-bit Reflectivity Product Strengths

1. Observe precipitation intensity, movement and trends

Like the Base Reflectivity product the radar operators can use 8-bit Reflectivity to determine the intensity of echoes, evaluate storm structure, and look for heavy snow bands, for example. Time lapses are an excellent tool for determining the movement of precipitation echoes, as well as the trends. Have the echoes gained or lost intensity? When will the rain begin? When will it end? All are questions that can be answered with the 8-bit Reflectivity product.

2. Weak returns in either Clear Air or Precipitatioin Modes displayed

The 8-bit Reflectivity product displays down to -30 dBZ in both clear air/precipitation modes. This can make the detection of low reflectivity boundaries, light precipitation, or snow more apparent than is possible in precipitation mode on the Base Reflectivity products.

3. Observe non-precipitation phenomena

The sensitivity of the WSR-88D allows non-precipitation features such as finelines, clouds, birds, and smoke plumes to be displayed. Some of these may be meteorologically significant, such as locating a focus for initial convection. A loop or using the distance speed tool can help determine the timing of a frontal passage.

4. Better resolution beyond 124 nm

The 8-bit Reflectivity Product uses .54 nm resolution out to 248 nm. This gives the operator a better perspective on returns beyond 124 nm.

5. Data levels

256 data levels vs. 16 data levels on the Base Reflectivity product.

Base Mean Radial Velocity and Spectrum Width

The highest resolution for base velocity and spectrum width products is 0.13 nm. This is representative of a 0.13 by 1° volume of the atmosphere.

Generation

Fig. 1-9 shows the method of choosing which data value will be used for display at lower resolutions. The 0.13 nm resolution product displays all 0.13 by 1° data. For the 0.27 nm resolution product the first of two consecutive 0.13 nm data values is displayed. The 0.54 nm resolution product displays the first of four consecutive 0.13 nm data values.

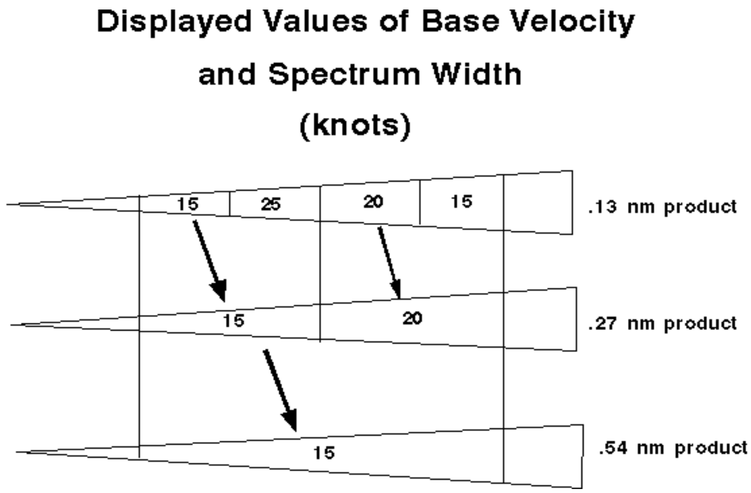


Figure 1-9. Values of velocity and spectrum width retained for display on products of different resolutions.

Implications to the operator

As seen in Fig. 1-10, because of this display method, echoes on these products will appear differently at various ranges with different resolutions. In contrast to reflectivity, even though the maximum velocity and spectrum width values are listed in the annotations area, they may not be displayed in the data on lower resolution products. This is because for the 0.27 nm and 0.54 nm resolution products, the maximum velocity and spectrum width values may have been ignored in selecting the first of the 0.13 nm range bins for display.

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Base Mean Radial Velocity

Characteristics

V product legend description:

- RPG ID: kxxx
- ELEVATION ANGLE: x.x in degrees
- PRODUCT NAME: Velocity
- UNITS: kts

- DATE: Day of week, time, and date **in UTC**

V product annotations:

- VCP: VCP 11, 21, 31 or 32
- Product Resolution: km
- Max/Min Value: MN: -xx kt MX: xx kt

Display Resolutions

The three resolutions and corresponding ranges of Base Velocity are 1° beamwidth by:

- 0.25 km / 0.13 nm - Range 32 nm
- 0.5 km / 0.27 nm - Range 62 nm
- 1 km / 0.54 nm - Range 124 nm

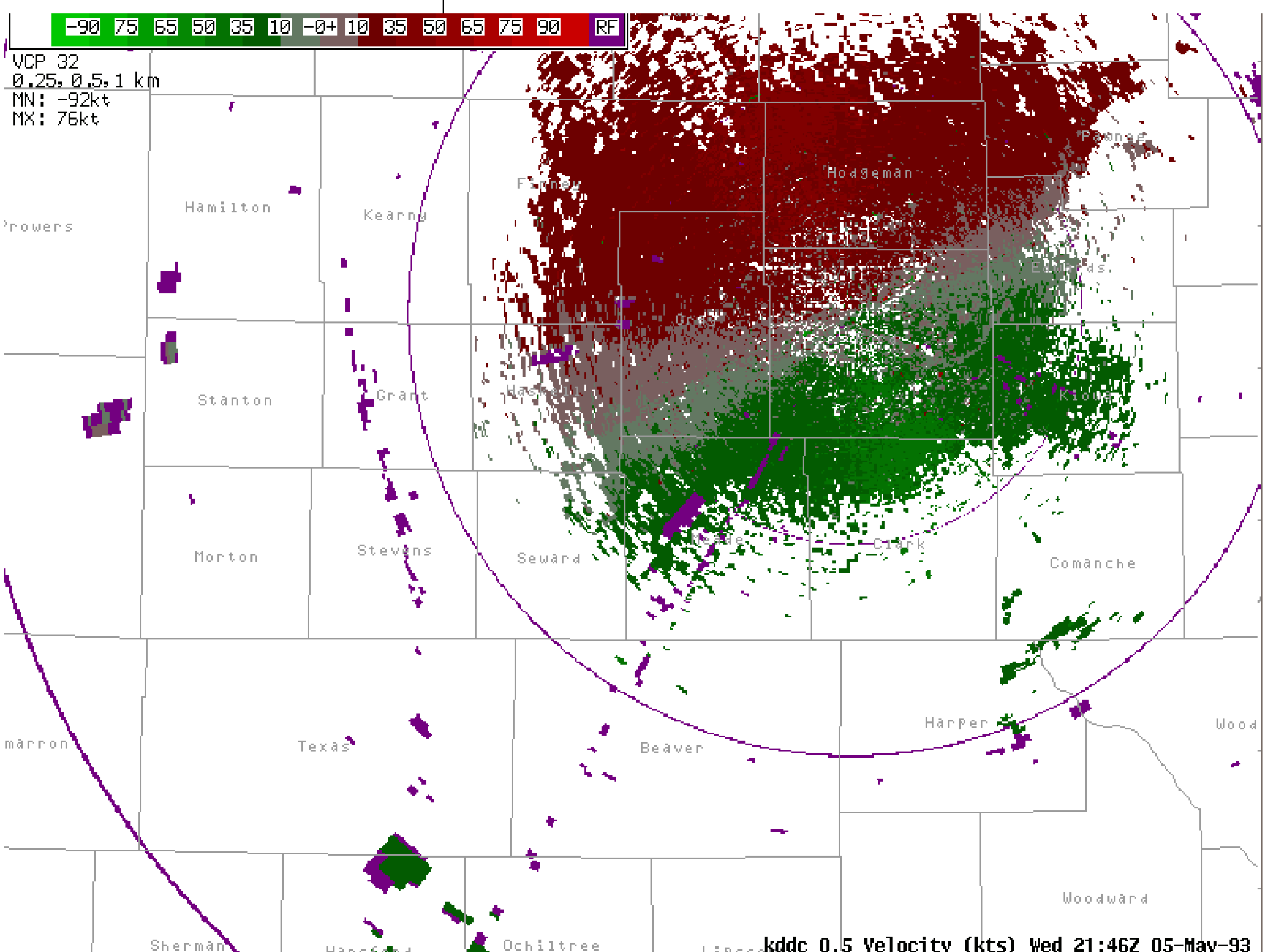

Figure 1-10. Example of displayed resolution differences on a velocity product. All three resolutions 0.13 nm, .27 nm and .54 nm are displayed. The purple range rings mark the resolution changes.

As with Base Reflectivity, AWIPS will display a Base Velocity product with the highest resolution available at each range, if the appropriate ranges are in the database.

Data Levels

Default values for the base velocity data levels:

- 16 level -64 to 64 knots
- 8 level -10 to 10 knots

Negative values represent inbound velocities, positive values represent outbound velocities.

Data levels are displayed using lower bound thresholds. As in Base Reflectivity, the numbers beside the color bar in the status and annotations area of the product are the lowest values in knots for the color. In Fig. 1-10, the color beside 35 kts

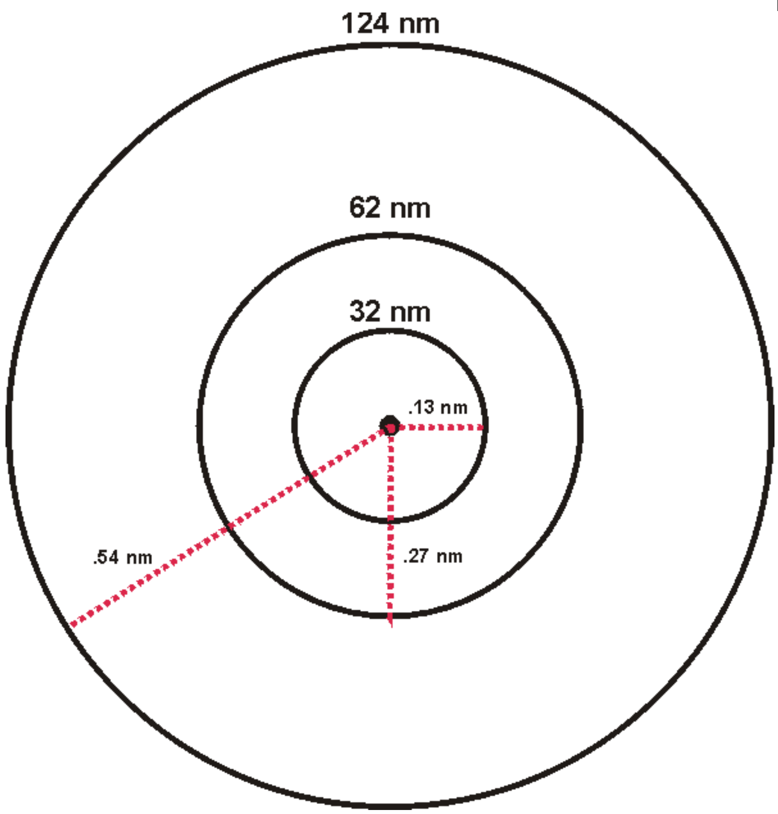

Figure 1-11. Base Velocity uses three different resolutions as available.

(outbound) actually represents the range from 35 to 49 kts. The color next to - 35 kts (inbound) represents the range from - 35 to - 49 kts.

Maximum velocity (inbound & outbound in knots) is noted in the product annotation area, and may occur at any location on the product displayed.

Changing data levels

Base Velocity data levels can be changed at the RPG HCI. Velocity data levels may be changed to highlight certain significant meteorological situations, such as severe thunderstorm criteria, low level jets, tropical storms, and gap and chinook winds in mountainous regions.

Velocity increments

For velocities less than 124 kts, an increment of 0.97 kts can be invoked at the RPG HCI. This allows the display of velocities up to + / -123 kts in one kt increments. To display velocities up to 246 kts, the velocity increment of 1.94 kts must be invoked at the RPG HCI. This allows the display of velocities up to + / -246 kts in two kt increments.

The data level colors may be changed in AWIPS.

There are six unique versions of Base Velocity, which are a combination of the 3 different resolutions and two data level sets. Base Velocity is generated at three resolutions (range dependent) and two data levels (8, 16 levels) for a combination of six different versions of Base Velocity.

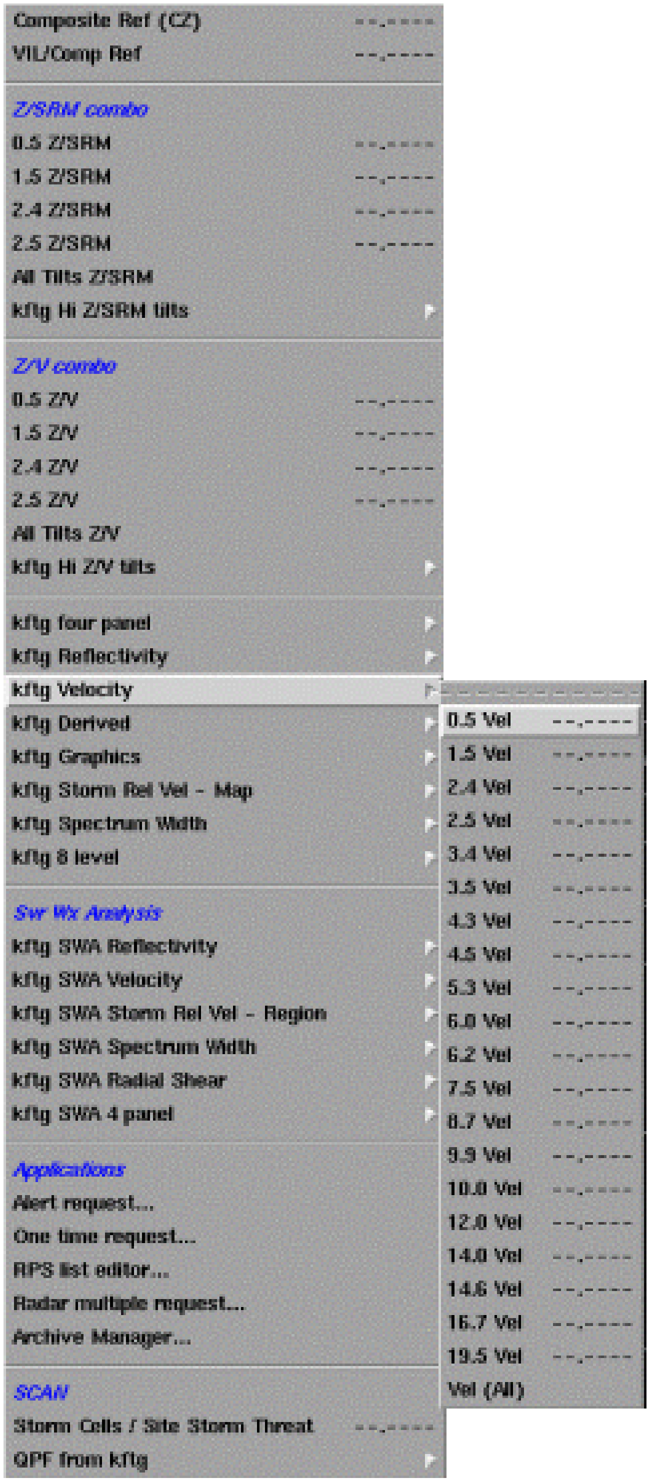

Figure 1-12. Base Velocity Menu.

Base Mean Radial Velocity Product Limitations

1. Range folding may obscure data

Recall from Radar Principles that the range unfolding algorithm compares the ratio of the power return from two targets separated by the maximum unambiguous range (R_{max}) to TOVER. If the ratio exceeds TOVER, the algorithm assigns velocity data to the target with the strongest power return. If the ratio does not exceed TOVER, neither echo is assigned the velocity value, which will then be designated as ambiguous and range folded. In many cases, range folding may obscure needed velocity data.

Operational Solutions

The radar operator has several options. If the area of interest is obscured by range folding, the RPG HCI operator can adjust the Pulse Repetition Frequency (PRF). This will change the R_{max}, and possibly move the range folding away from the area of interest. The available PRF numbers, 4 through 8, can place R_{max} from 94 to 63 nautical miles.

Range folding may be caused by nearby ground returns that are obscuring data in the second trip. Invoking appropriate clutter suppression at the RPG HCI will reduce the power associated with the ground returns. The area of interest at the second trip may then be the dominant return. If TOVER is exceeded, the 2^{nd} trip return will then be given a usable velocity value.

Selecting a higher slice may overcome range folding problems, especially if an area of interest in the first trip is being obscured by data in the second trip. By choosing a higher elevation angle, the beam may overshoot the target in the second trip, and display usable velocity data for the area of interest in the first trip.

The operator may dial in to another site for a different look at the same storm. For example, the WSR-88D at Indianapolis, IN may be experiencing range folding problems with a storm to their east. The same storm may not be range folded when viewed from the Wilmington, OH WSR-88D.

2. Improper velocity dealiasing may display erroneous velocity values.

The Velocity Dealiasing Algorithm checks each first guess velocity value with neighboring bins. As a last resort, the dealiasing algorithm compares the velocity data to the environmental winds. Failures occur due to lack of surrounding data, or an out of date environmental winds table.

Operational Solutions

The RPG HCI operator should ensure the Environmental Winds Table represents the atmospheric flow. Keeping the environmental winds table representative should minimize dealiasing failures especially in VCP 31, where V_{max}=22 kts. It will also prevent initial dealiasing failures from propagating through numerous radials.

Increasing the PRF at the RPG HCI will increase V_{max}, and decrease the amount of aliased velocities. The dealiasing algorithm will have fewer velocities to dealias, and less chance for error.

The same problem may not show up on a different elevation slice.

The user can request products from another site for a different look at the same storm. An adjacent site may not be having the same dealiasing problem.

3. Data levels

Details may be obscured with an 8 data level product. If the 8 data level base velocity is adjusted to highlight higher velocity values, the lower speeds may be obscured in the wider range between data levels.

Operational Solution

Use a 16 data level Base Velocity Product, or adjust the data levels to highlight the speeds of interest.

Base Mean Radial Velocity Product Strengths

1. Magnitude

Estimate magnitude of radial velocities. Ground relative wind speeds can be estimated for use as input into warnings, statements, and forecasts.

2. Atmospheric Structure

Determine radial velocity patterns to infer atmospheric structure. Veering or backing winds with height can identify warm air or cold air advection. Low level or mid level jets can be easily identified on the base velocity product.

3. Storm Structure

Determine radial velocity patterns to infer storm structure. Cyclonic and anticyclonic rotation, storm top divergence, divergence at the surface from microbursts all can be determined from the Base Velocity Product.

4. Hodographs

Aid in creating, adjusting, or updating hodographs. Hodographs can be created not only for the sounding location or the RDA, but also in the vicinity of a nearby boundary. Wind profiles can be determined to update the hodograph to reflect any changes that may have occurred between soundings.

8-bit Velocity (High Resolution)

Generation

The ***only*** resolution available for the 8-bit velocity is 0.13 nm. This is representative of a 0.13 nm by 1° volume of the atmosphere. After the base data is created, it is transmitted to the RPG via the wideband link. Unlike the Base Velocity product, that only displays 0.13 nm resolution to 32 nm, the 8-bit Velocity displays 0.13 nm resolution out to 124 nm.

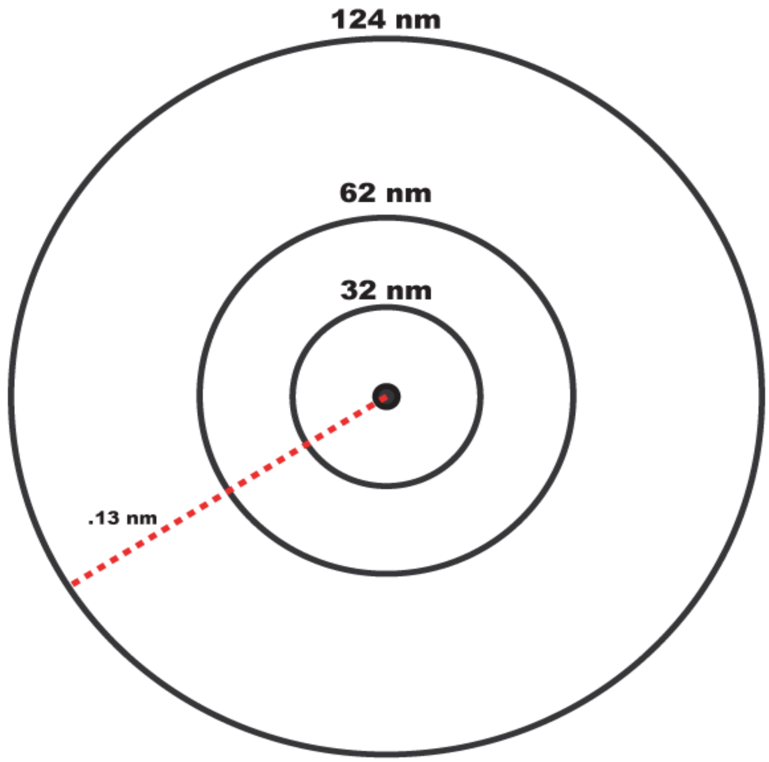

Figure 1-13. 8 bit Velocity uses one resolution.

Characteristics

8-bit Vel product legend description:

- RPG ID: kxxx
- ELEVATION ANGLE: x.x in degrees
- PRODUCT NAME: 8-bit Velocity
- UNITS: kts
- DATE: Day of week, time, and date **in UTC**

8-bit Vel product annotations:

- VCP: 11, 21, 31 or 32
- Product Resolution: (NA) km
- Max/Min Value: (NA) dBZ

Display Resolution

The only resolution and corresponding range of 8-bit Velocity is 1° beamwidth by:

- .13 nm / 1/4 km - Range 124 nm

Data Levels

Clear Air Mode (Mode B) VCPs 31 and 32

256 Data levels: > 100 kts inbound/outbound

Precipitation Mode (Mode A) VCPs 11 and 21

256 Data levels: -100 kts to +100 kts

The AWIPS readout is to the nearest 0.5 kt. Negative values represent inbound velocities, positive values represent outbound velocities

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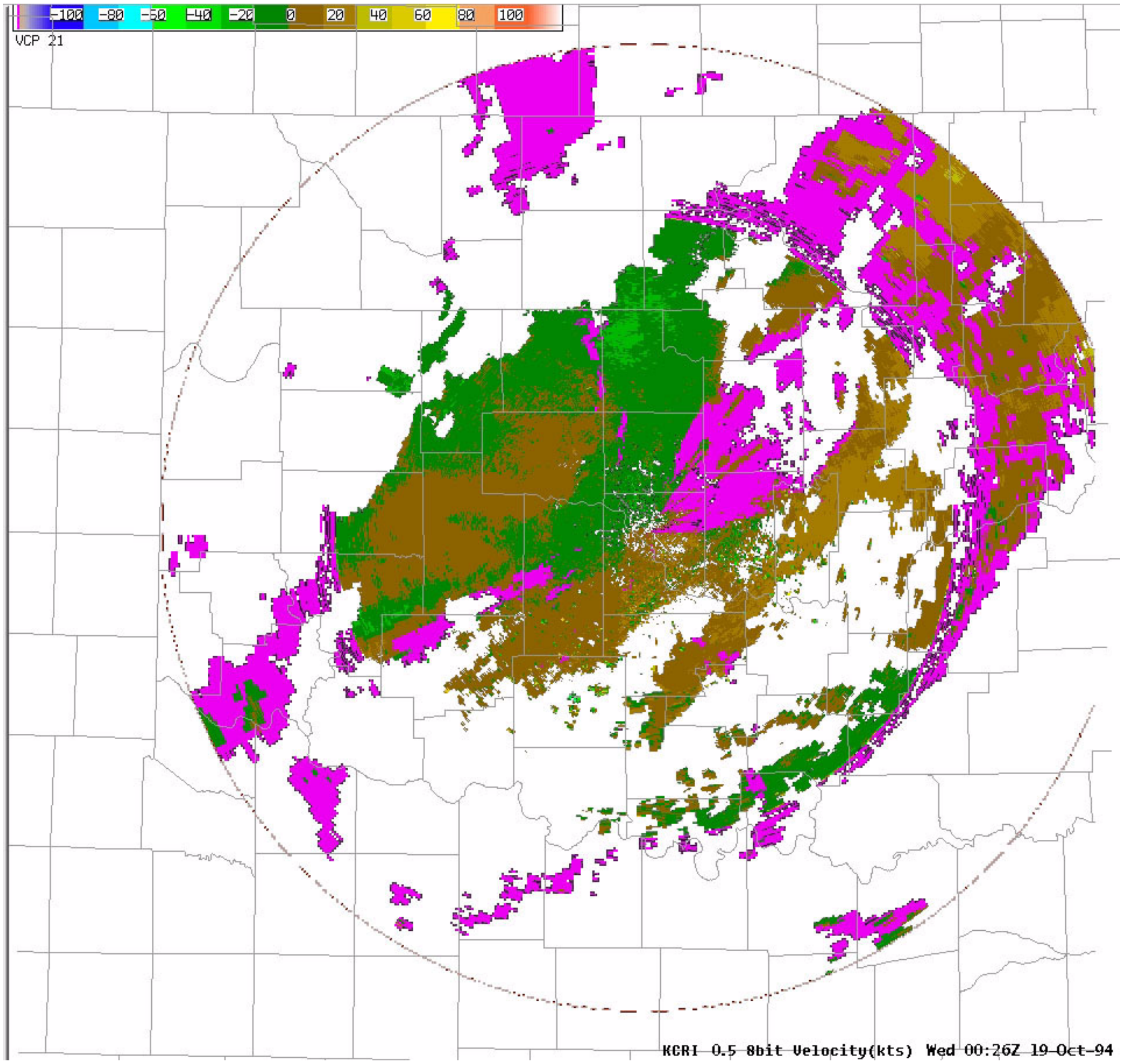

Figure 1-14. This 8-bit Velocity product has a maximum range of 124 nm. The resolution is .13 nm out to 124 nm. (.13 nm is the only resolution available for the 8-bit Velocity product)

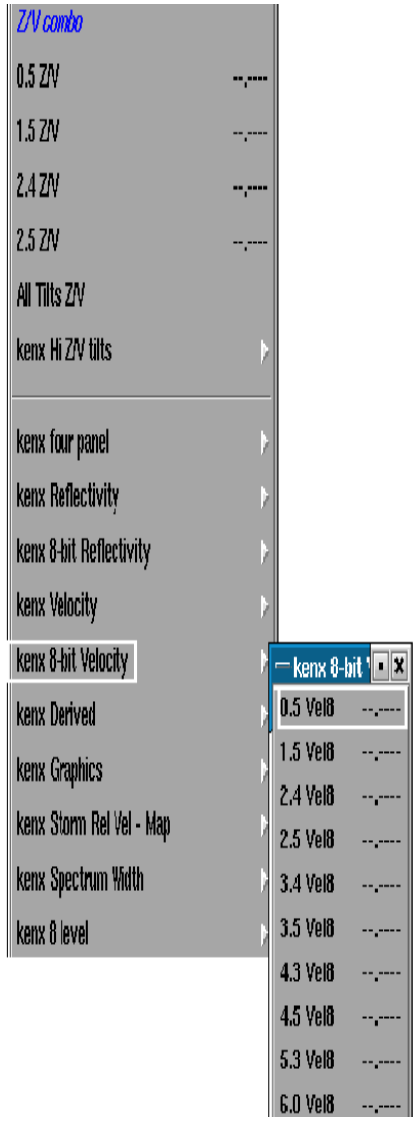

Figure 1-15. 8-bit Velocity product menu.

8-bit Velocity Product Limitations

1. Range folding may obscure data

Recall from Radar Principles that the range unfolding algorithm compares the ratio of the power return from two targets separated by the maximum unambiguous range (R_{max}) to TOVER. If the ratio exceeds TOVER, the algorithm assigns velocity data to the target with the stronger power return. If the ratio does not exceed TOVER, neither echo is assigned the velocity value, which will then be designated as ambiguous and range folded. In many cases, range folding may obscure needed velocity data.

2. Improper velocity dealiasing may display erroneous velocity values.

The Velocity Dealiasing Algorithm checks each first guess velocity value with neighboring bins. As a last resort, the dealiasing algorithm compares the velocity data to the environmental winds. Failures occur due to lack of surrounding data, or an out of date environmental winds table.

3. Products lacking in AWIPS 5.2.2

AWIPS 5.2.2 does not have an 8-bit storm relative product, nor can the operator combine Z and V and still maintain resolution.

8-bit Velocity Product Strengths

1. Resolution

The 8-bit Velocity Product uses .13 nm resolution out to 124 nm giving the operator the best available perspective on returns out to 124 nm resulting in increased spatial/data resolution.

2. Magnitude

Estimate magnitude of radial velocities. Ground relative wind speeds can be estimated for use as input into warnings, statements, and forecasts.

3. Atmospheric Structure

Determine radial velocity patterns to infer atmospheric structure. Veering or backing winds with height can identify warm air or cold air advection. Low level or mid level jets can be easily identified on the base velocity product.

4. Storm Structure

Determine radial velocity patterns to infer storm structure. Cyclonic and anticyclonic rotation, storm top divergence, divergence at the surface from microbursts all can be determined from the Base Velocity Product.

5. Hodographs

Aid in creating, adjusting, or updating hodographs. Hodographs can be created not only for the sounding location or the RDA, but also in the vicinity of a nearby boundary. Wind profiles can be determined to update the hodograph to reflect any changes that may have occurred between soundings.

Base Spectrum Width

Characteristics

SW product legend description:

- RPG ID: kxxx
- ELEVATION ANGLE: x.x in degrees
- PRODUCT NAME: Spectrum Width
- UNITS: kts
- DATE: Day of week, time, and date **in UTC**

SW product annotations:

- VCP: VCP 11, 21, 31 or 32
- Product Resolution: km
- Max Value: MX xx kt

Display Resolutions

As with reflectivity and velocity, AWIPS will display a Spectrum Width product using the best resolution data available in the database. The three resolutions and corresponding ranges of Base Spectrum Width are 1° beamwidth by:

- 0.25 km / 0.13 nm - Range 32 nm
- 0.50 km / 0.27 nm - Range 62 nm
- 1.0 km / 0.54 nm - Range 124 nm

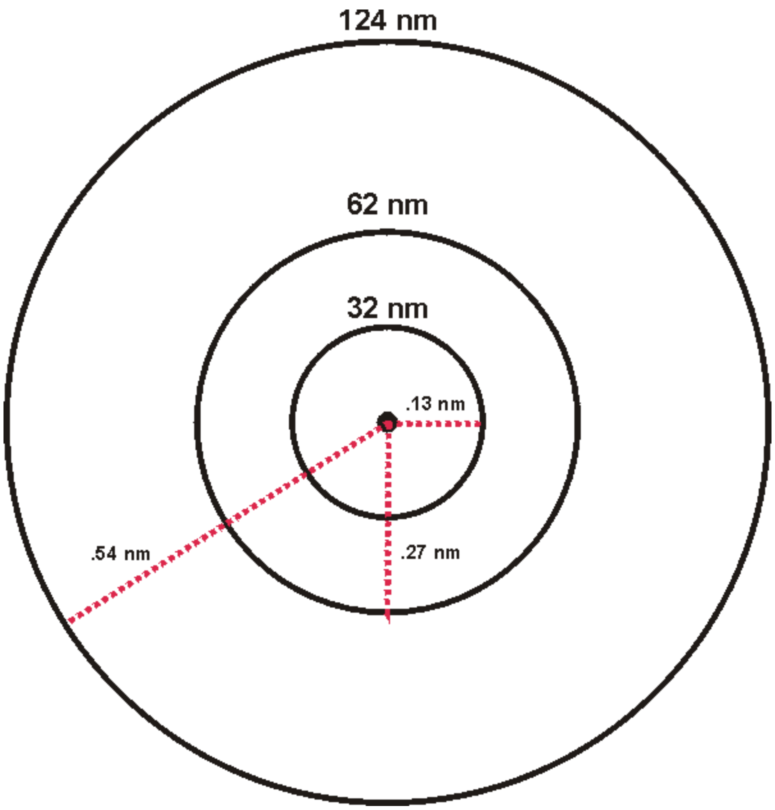

Figure 1-16. The Base Spectrum Width product uses three different resolutions as available.

Data Levels

8 Data Levels range from 0 to 20 knots.

Data level values for Spectrum Width do not change with operational mode change. Data levels are displayed using lower bound thresholds.

Maximum spectrum width is truncated at 19 knots. Spectrum Width values above 19 knots are above the maximum theoretical wideband noise value. Since these values are system related and not data related, they are not displayed.

The maximum spectrum width is displayed in the annotations area, and may occur at any location on the product displayed. Data levels can not be adjusted.

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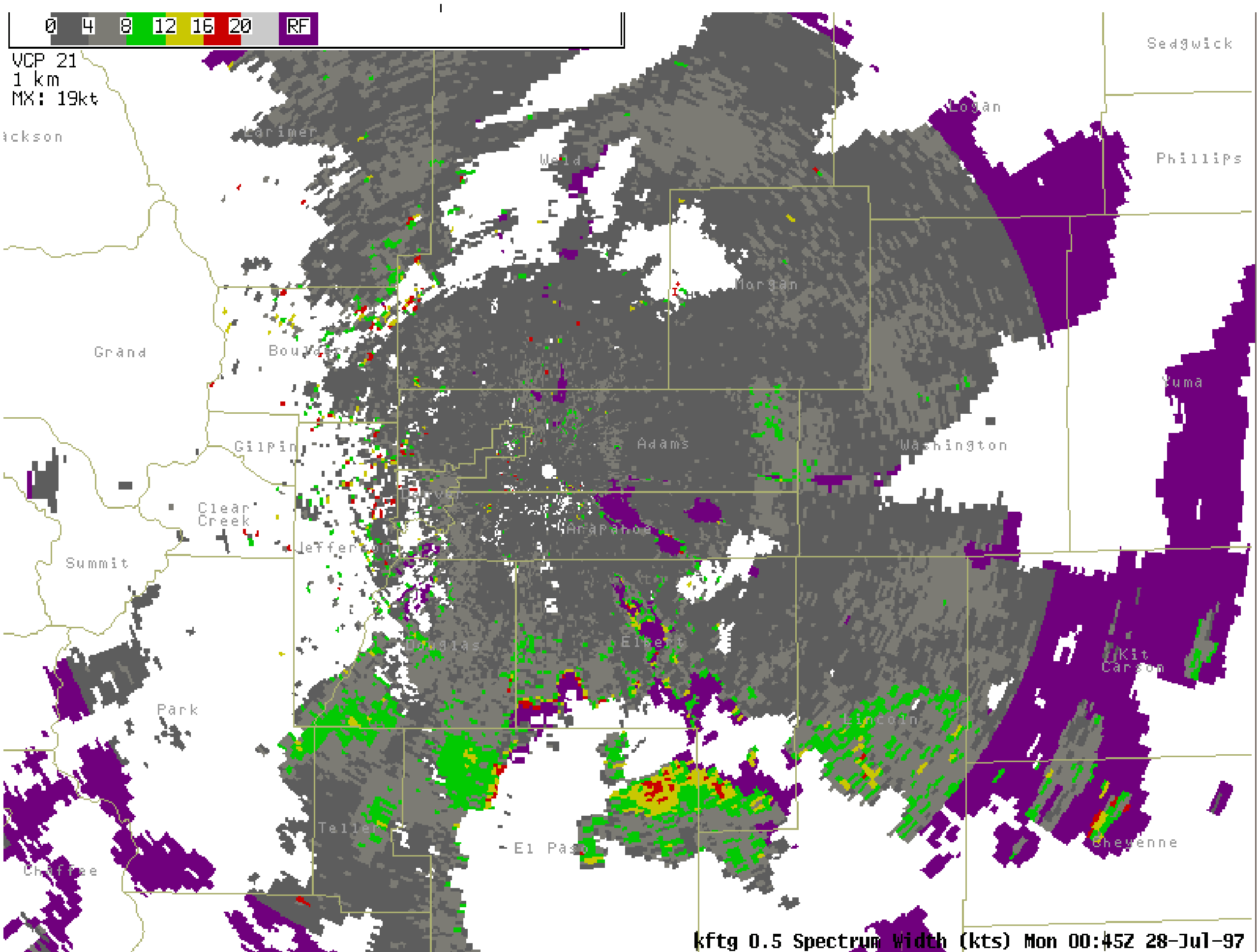


Figure 1-17. Base Spectrum Width.

Figure 1-18. Base Spectrum Width Menu.

Typical values

High base spectrum width values result from large velocity differences within a range bin. High velocity differences can result from turbulence, wind shear, differing fall velocities, or from non-meteorological factors.

Stratiform Precipitation

For stratiform precipitation, one would not expect large dispersions in the range bin. Typical spectrum width values for stratiform precipitation are low, in the 0 to 7 kt range.

Turbulent Flow

More variations in the range bin will occur in returns from turbulent areas, such as thunderstorms and outflow boundaries. In those areas, one can expect to see spectrum width values above 8 kts.

Melting Level

Differing fall velocities of rain, wet snow, and snow in the melting level will result in a typical spectrum width of 8 kts.

Base Spectrum Width Product Limitations

1. Range Folding

As with the Base Velocity Product, range folding may obscure needed spectrum width data.

Operational Solutions

The same solutions for overcoming range folding in base velocity apply to spectrum width as well. Changing the PRF, invoking clutter suppression, viewing a different elevation angle, and requesting products from another site are all options available to the radar operator.

2. Ground Clutter

Movement of ground clutter may result in high spectrum width values. For example, cars on the road and blowing leaves on trees in the summer can contribute to high velocity variances in the range bin. Turbulent flow around ground targets such as buildings and water towers may also result in high spectrum widths.

Operational Solution

Invoke appropriate clutter suppression at the RPG HCI for the area of concern.

3. System Noise

Although Base Spectrum Width is truncated at 19 kts to eliminate system noise, spectrum widths from returns near the noise threshold may lead to erratic values. These will be most noticeable as high (12 kt or greater) spectrum widths scattered throughout clear air returns.

Operational Solutions

Try a higher elevation angle or make a request from another site.

4. Transmission Time

Large amount of time is required to send Base Spectrum Width products down the narrowband line.

Operational Solutions

If Base Spectrum Width is not used often, limit the number of slices on the RPS list. Do onetime requests for additional elevation angles as needed.

A second solution is to change to a lower resolution. A 0.54 nm Base Spectrum Width typically has less data to display than a 0.13 nm or 0.27 nm product, and will take less time to transmit down the narrowband line.

Base Spectrum Width Product Strengths

1. Evaluate Velocity

Spectrum width can be used to evaluate the reliability of Base Mean Radial Velocity products. Generally speaking, a higher spectrum width value implies more uncertainty in the velocity estimate. ***This may indicate, but does not necessarily mean that the displayed velocity is incorrect***.

WSR-88D operators need to look at all the Base Products to determine if the velocity data are accurate. For example, if a Base Velocity Product has strong inbound velocities next to strong outbounds, with associated Spectrum Widths > 12 kts, the radar operator should check reflectivity data as well. The velocity signature may be expected after looking at storm structure.

Base Product Limitations

This section addresses limitations that apply to ***all base products***, and offers some suggestions to overcome them.

1. Ground Returns

Limitation

Residual clutter and ground returns from superrefraction may contaminate products.

Operational Solutions

- Invoking clutter suppression at the RPG HCI should be the first action an operator takes to reduce ground returns. Base Products can be used to evaluate the Base Data that is being used in all the algorithms. Ground returns not only make Base Products hard to interpret, but they can also contaminate the derived products.
- Viewing a higher elevation angle will display data that was sampled above the ground returns.
- An adjacent radar site may not be experiencing superrefraction. Requesting products from that site will help the operator view an area of interest without contamination from AP.

2. Beam Blocking

Limitation

- Beam blocking is possible especially on lower elevation angles. When sites for the radars were chosen, one of the considerations was to minimize blockage of the beam. Unfortunately, that is not possible in every case.

Operational Solutions

- Solutions to beam blockage are choosing a higher elevation angle to overshoot the target that is blocking the radar beam, or requesting from an adjacent site to view the areas that are being obscured.

Limitation | **3.** Resolution vs Range

- Beam broadening will cause worse resolutions at longer ranges.

Operational Solution

- Call another site closer to the return.

Limitation | **4.** Effects of Earth Curvature

- Beam centerline increases in altitude with range. The radar may then overshoot significant features at low levels and far ranges.

Operational Solution

- Access a closer radar that samples the feature at lower altitudes. Be aware of the importance of spotter input at these far ranges.

Limitation | **5.** Effects of Discrete Elevation Sampling

- Echoes may be poorly sampled by the VCP in use depending on range and echo geometry. A small storm at far ranges will be more poorly sampled than the same storm close in. In addition, a close storm will be more poorly sampled in VCP 21 than VCP 11.

Operational Solution

- Operate in VCP 11 if possible when echoes are present, especially if storms are within 60 nm of the radar.
- Accessing other radars may show the same storm at different altitudes.

Limitation | **6.** Cone of Silence

- Data are unavailable for higher altitudes close to the RDA. The highest elevation angle is 19.5^{o} in VCPs 11 and 21. Data above 19.5^{o} is not available for display on any of the Base Products.

Operational Solution

- Request Base Products from an adjacent site to display data in the cone of silence where data are needed. If the closest neighboring

WSR-88D is beyond 124 nm, Base Velocity and Base Spectrum Width will not be able to display data in the other radar's cone of silence.

7. Chaff

Limitation

- Chaff may cause large areas of non-meteorological echoes. It is detected by radar after being dropped from airplanes, and begins with initial returns in a small area between 20 and 40 dBZ. The returns at first resemble pulse type thunderstorms, and can be very confusing to a radar operator. Over time, the chaff will spread out with the mean wind flow both horizontally and vertically. It will slowly decrease in intensity to very low dBZs. It is characterized on the radar as an elongated echo. Base velocity products will show wind structure that is relative to the wind fields with no turbulence noted. Spectrum widths are usually less than 6 kts. Chaff will give excellent reflectors for your VAD Wind Profile over a great depth of the atmosphere.

Operational Solution

- Review all types of observation systems to make a determination on chaff. Satellite, surface observations, other radar sites, and spotters are tools that can be used.
- Watch for high dBZ during initial release, with gradual decrease in intensity and spreading with mean wind flow and vertical dispersion.
- Look for reoccurrence over the same areas upwind of flight routes, military operations areas etc.
- Military points of contact are often unable to disclose chaff drops. During an exercise the decision may be up to the pilot to drop chaff, and is not necessarily a coordinated scheduled chaff release.

Base Product Strengths and Applications

1. Evaluate environmental conditions and meteorological characteristics	Vertical density discontinuities such as inversions and layers where moisture decreases rapidly with height will show up as rings or partial rings around the RDA site.
2. Identify cloud layers and precipitation characteristics	The use of Clear Air Mode can be extremely useful during winter storm events. A 16 data level Reflectivity product can help locate heavier snow bands. Also, be sure to have an 8 data level Reflectivity product on your RPS list during clear air operation to note reflectivity returns greater than 28 dBZ.
3. Determine location and motion of troughs, fronts and other boundaries	Base products are an excellent tool to use in determining location of boundaries. Use base reflectivity to locate finelines, and base velocity to look for areas of convergence along a boundary. If possible, use base products in clear air mode for increased sensitivity. Base Reflectivity in clear air mode will display reflectivities down to -28 dBZ, allowing the operator to see features with low returns such as fronts and drylines.
4. Locate and identify the melting level	A melting level of uniform height can be identified as a ring, or partial ring, of slightly higher reflectivity values in the Reflectivity product. If the height of the melting level varies with range from the radar, the ring will be asymmetric and/or the melting level may appear as an arc or as an irregular band. This radar characteristic will coincide with one of slightly higher spectrum width values around 8 knots.
5. Determine significant storm structure features	Several storm structure features can be readily identified using base products including Weak Echo Regions (WER), Bounded Weak Echo

Regions (BWER), hooks, Rear-Inflow Jet, or Weak echo channels, Microbursts and differing Supercell characteristics just to name a few. While base velocity may show rotation in a thunderstorm because of the way the data are displayed, it is recommended that you use the Storm Relative Velocity product (SRM or SRR) to calculate rotational velocities in association with mesocyclones.

6. Identify non-meteorological phenomena

Many non-meteorological phenomena can be detected on the radar. Bird, bat and insect flight patterns may be viewed. The radar can be used to track range fires as well as locate possible areas where forest fires have started. Furthermore, the radar will be useful to locate volcanic ash, airplanes, chaff droppings and even speeders on the highway. As an operator, you must be constantly aware of the potential for non-meteorological phenomena being detected. Remain alert and always use all resources possible to make a determination on what you are viewing.

7. Locate suspected areas of turbulence and shear regions

Shear and turbulence are meteorologically significant. One example of an intense shear region is near the top of a thunderstorm in association with storm top divergence. An 8 data level Base Velocity product can be useful for locating areas where storm top divergence is occurring. Changing the color levels to highlight the highest two velocities can help. Rapid changes in speed and direction seen on the Base Velocity Product can help locate areas of vertical shear that may be hazardous to aircraft.

Lesson 2: Interpretation of Doppler Velocity Patterns

Review from I.C. 5.3

1. When interpreting velocity products, ***radial*** velocities are displayed, which are ***not*** the true velocities.
2. Improperly dealiased velocities and range folding ***can*** inhibit interpretation on velocity products.

Overview

In this lesson, you will learn:

- The basic principles used to identify radial velocity signatures.
- How velocity displays relate to the vertical wind profile.
- How to use velocity interpretation principles with WSR-88D velocity products.

Objectives

Without references, and in accordance with the lesson, you will be able to:

1. Interpret Doppler velocity patterns under uniform, non-uniform, ambiguous, and meteorologically complex conditions identifying:

   a. inbound vs. outbound flow

   b. velocity data level intervals

   c. constant wind speed and direction

   d. wind speed and direction changing with height

   e. velocity maxima

   f. confluence and diffluence

   g. vertical discontinuities

   h. boundaries

   i. convergence and divergence

   j. cyclonic and anticyclonic rotation

   k. any combination of the above

2. Construct vertical wind profiles for uniform and non-uniform horizontal wind conditions.
3. Assess the meteorological conditions associated with the identified velocity patterns.

Introduction

In this section we will interpret velocity signatures from both clear air and widespread precipitation events, including some signatures associated with convective storms.

Velocity Display

When looking at a velocity product, you are viewing the display from above looking into a cone.

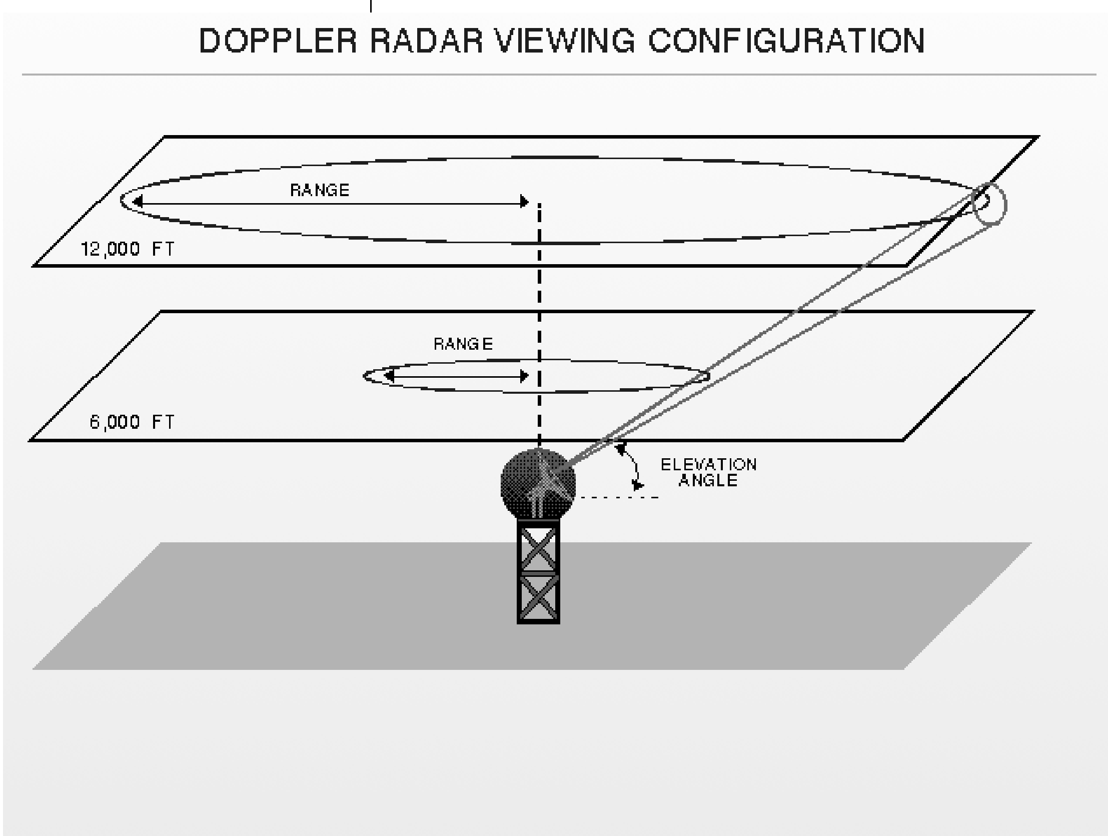


Figure 2-1. The slant range on the edge of the display corresponds to a height above the ground.

It is important to note that as you move away from the RDA, you are also moving up in height. Using this concept, we can infer a 3-D wind field from a single elevation angle velocity product.

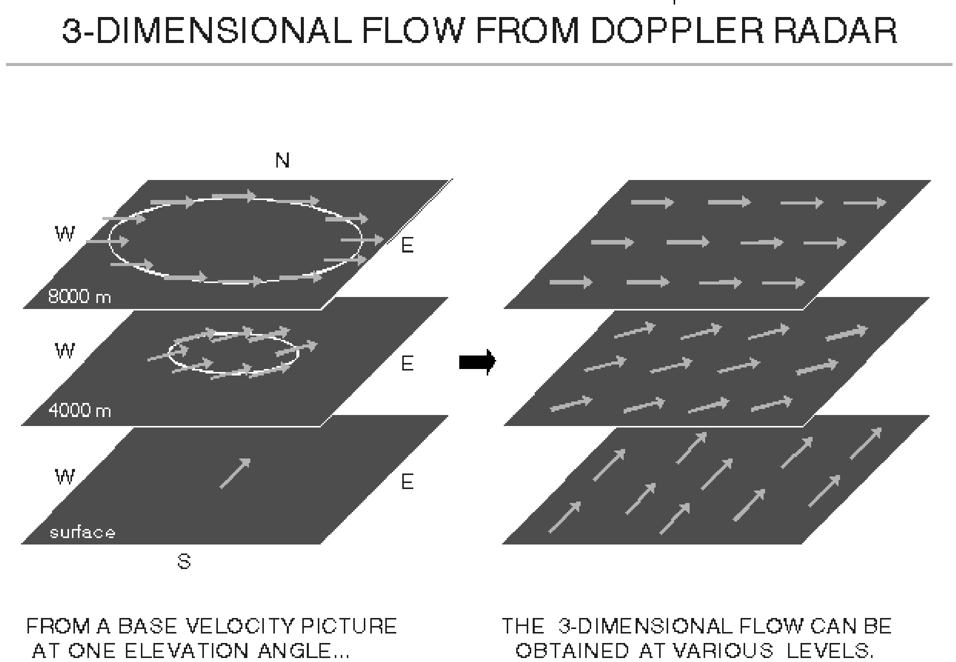


Figure 2-2. 3-D Wind Field

When viewing a velocity product, you are actually viewing a 3-D wind flow on a 2-D display. At the AWIPS workstation, hold down the left mouse button at a selected cursor location. This will display the height in feet (AGL/MSL), azimuth/range (Statute Miles) and radial velocity (Knots).

Radial Velocities

Fig. 2-3 depicts the radar's ability to measure velocities and what the operator sees. When the wind is parallel to the radial, the full component of the wind is measured. As the radial becomes more perpendicular to the actual wind, the radial component decreases. When the radial is perpendicular to the wind, the radar displays zero velocity, but the actual velocity has not changed.

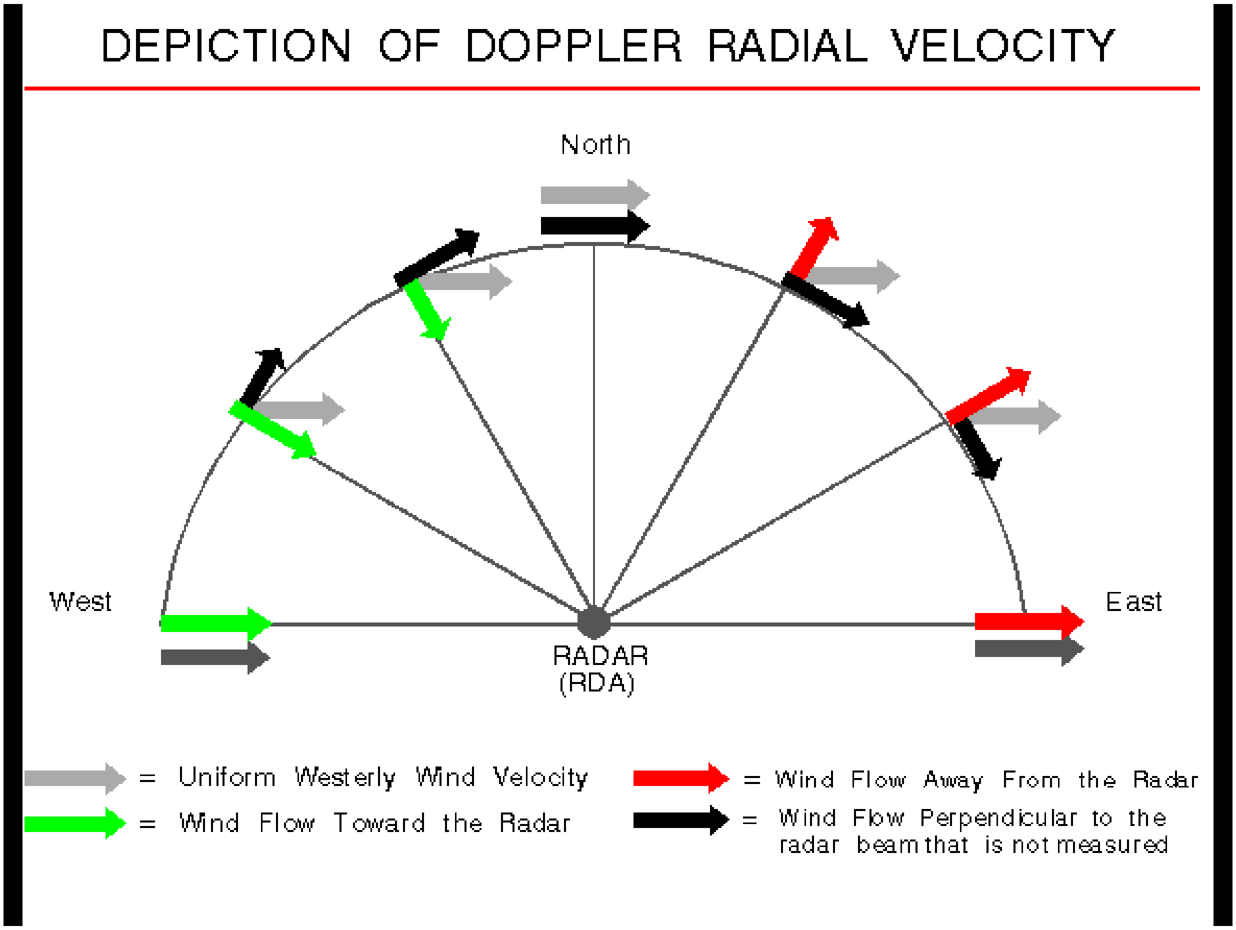


Figure 2-3. In this figure, the gray arrows depict the actual velocity, the green/red arrows depict the component of velocity measured along the radial. The black arrows depict the component of velocity perpendicular to the radial, which the WSR-88D does not detect.

This is the reason that the colors change or speed seems to decrease as you move away from the actual wind direction/speed (Fig. 2-4).

Colors

Colors can be changed by agencies and individuals. Because of these reasons, ***always*** refer to the color scale associated with that product before you attempt to interpret the product.

The reason that inbound velocities (cool colors) are negative and outbound velocities (warm colors) are positive is that the first Doppler radars pointed straight up, so downdrafts (negative vertical motion) pointed toward the radar.

Definitions

At this point in time it is important to define some terms.

Zero Velocity

The actual speed is zero ***or*** the direction is perpendicular to the beam.

Isodop

An isodop is a line of ***constant Doppler (radial) velocity.***

Zero Isodop

A zero isodop is a line of ***constant zero Doppler (radial) velocity.***

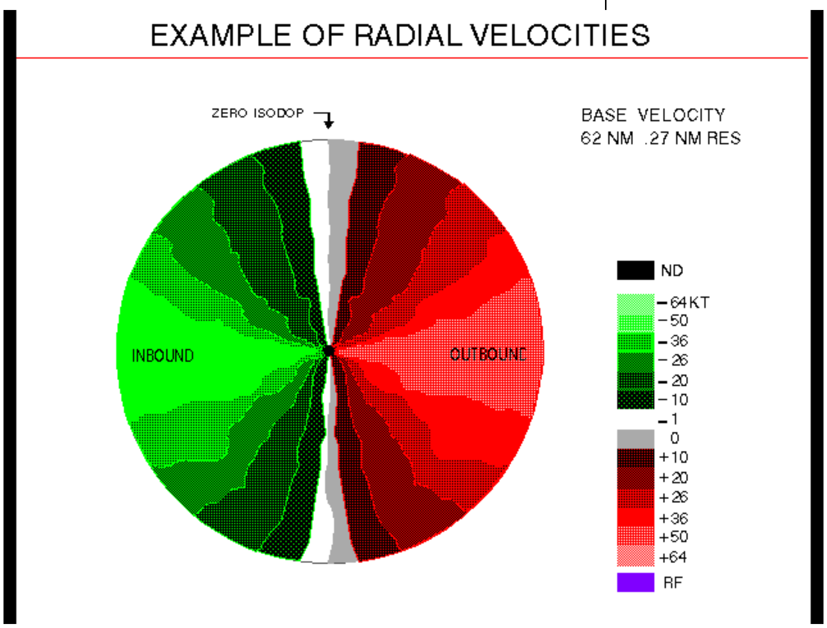


Figure 2-4. Radial velocity pattern for homogeneous westerly flow.

The zero isodop is used to determine wind direction.

Direction

A zero isodop with inbound velocities on one side and outbound on the other normally indicates wind perpendicular to the radar beam.

A straight zero isodop across the display will normally indicate ***uniformly directional flow*** at all levels.

Methods

We have methods to use the zero isodop to help determine wind ***direction*** when it is changing with height.

Determining direction using the zero isodop

1. Draw a line along a radial from the RDA to some point on the zero isodop.

2. At this point, draw an arrow ***perpendicular to the line along the radial.*** Point this arrow from inbound to outbound.

3. Assuming homogeneous flow, the arrow represents the ***wind direction at that range (height).***

or

Max In/Outbound

In cases with good sample coverage, use the maximum inbound/outbound velocities at a constant range (height) to determine direction.

There will be many cases when one of the methods outlined above will not work. At times the operator will have to use a combination of the two methods.

Speed

Wind speed at a particular range (height) is determined by the highest Doppler velocity at that range if in a homogeneous flow field.

Examples

The highest Doppler velocities can normally be found about $\pm$ 90° from the zero isodop.

Zero Isodop Example

By using the methods described previously, we can determine the wind direction at any range (or height). It is very important to draw the arrows ***perpendicular to the line from the RDA (radial), not the zero isodop*** itself. Fig. 2-5 shows the lines drawn out from the RDA. Fig. 2-6 shows the lines and the arrows which indicate the direction.

All the computer patterns have the center at the RDA, with the first range ring indicating low level velocities. The second range ring indicates mid level velocities and the edge of the display indicates high level velocities.

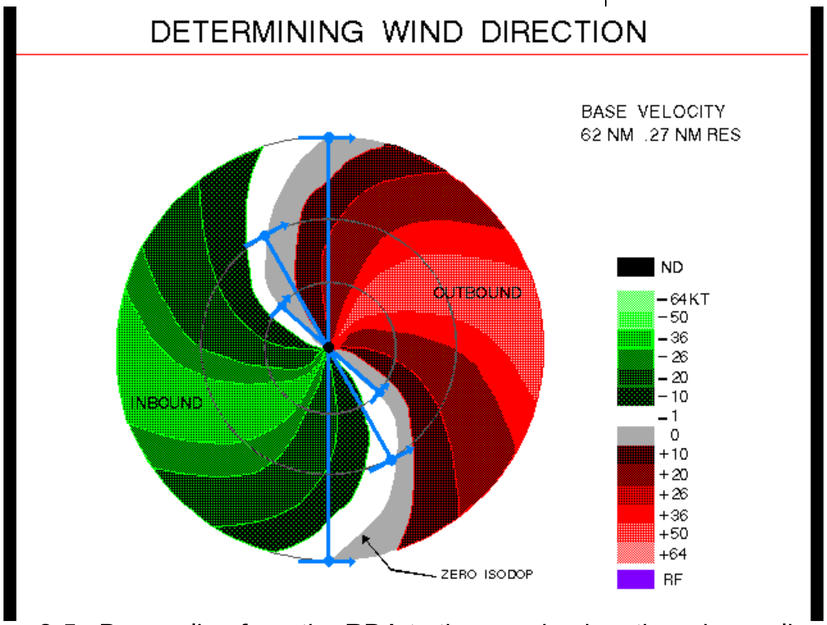


Figure 2-5. Draw a line from the RDA to the zero isodop, then draw a line perpendicular to the radar radial at that point.

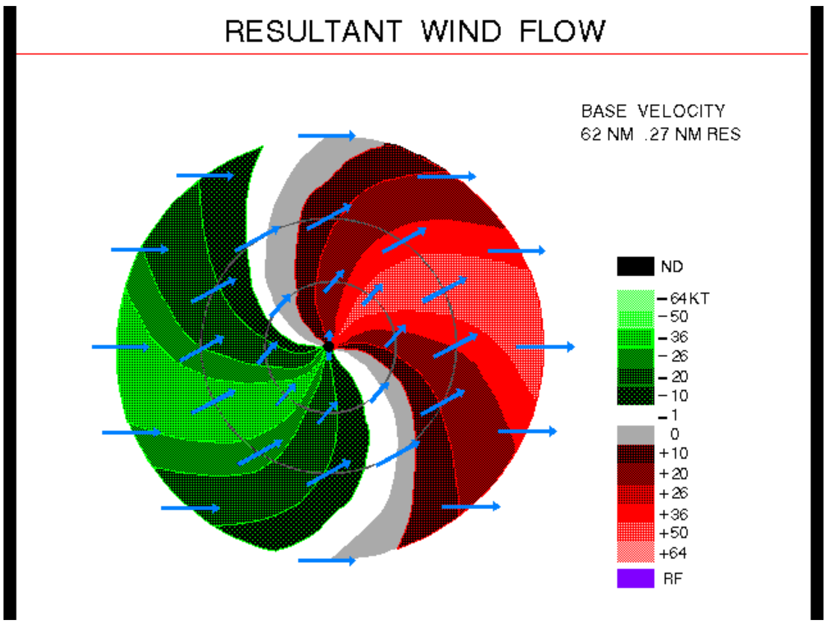


Figure 2-6. Arrows depicting the flow at each range ring.

Constant Direction With Height

Note in Fig. 2-7 that the zero isodop is a straight white line across the display. A straight zero isodop indicates uniform direction. In Fig. 2-7, the wind direction is uniformly west to east from the surface out to the edge of the display. Also note that this example has isodops that all converge at the RDA. This indicates that the wind speeds are also uniform. For any given range (height), the same maximum inbound and outbound values are encountered.

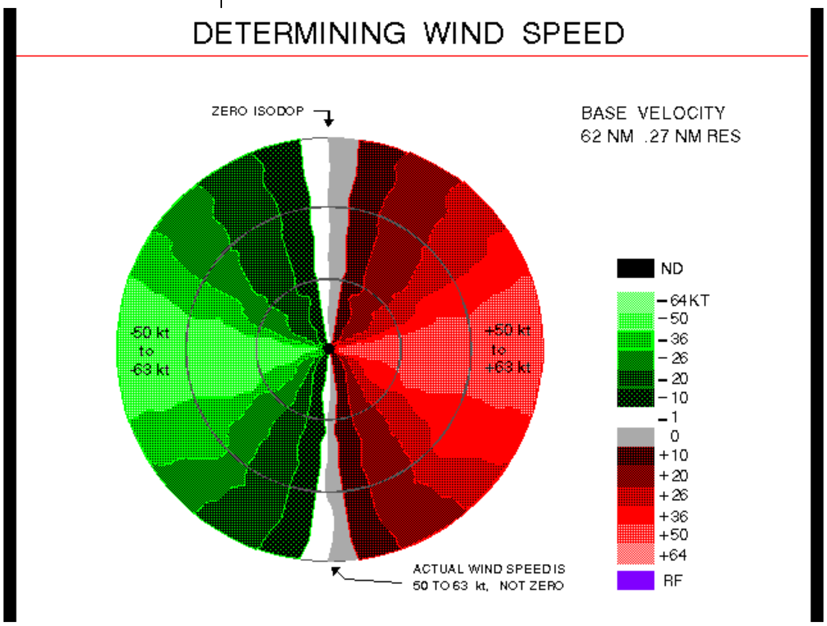


Figure 2-7. Radial velocity pattern for homogeneous westerly flow. Note the straight zero isodop indicating uniform direction and the isodops converging at the RDA indicating uniform speed.

Fig. 2-8 is a WSR-88D example of a relatively straight zero isodop which is oriented southwest to northeast. Winds from northwest to southeast are indicated (green inbound, red outbound) from near the surface to the edge of the display.

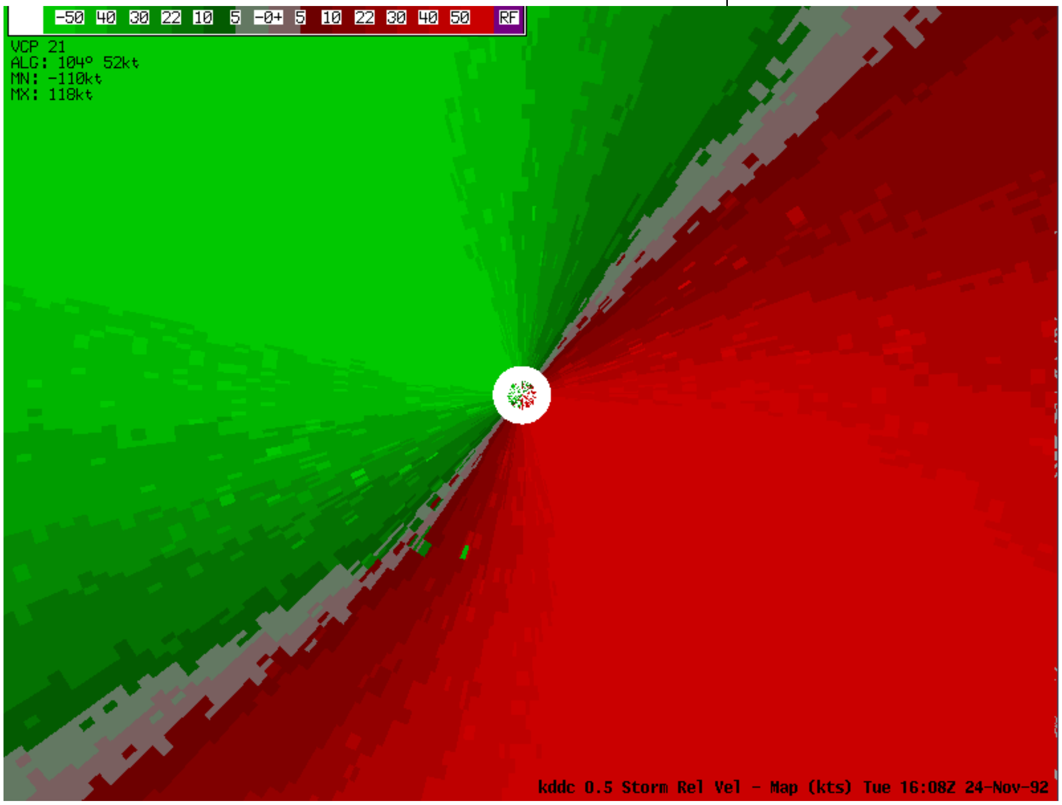


Figure 2-8. Straight zero isodop example, indicating flow from the northwest.

Wind Maxima

A wind maximum is identified by closed isodops surrounding a maximum velocity value. Fig. 2-9 shows the closed isodops indicating velocity maxima between the first and second range rings (from west to east). Greater than zero isodops converge at the RDA. Note that the wind speeds decrease as you approach the edge of the display with calm winds at the height corresponding to the edge.

Fig. 2-10 has low level wind maxima with lighter winds surrounding the maxima. The low level winds are basically from north-northeast to south-southwest and quickly increase from about 10 kts to near 50 kts.

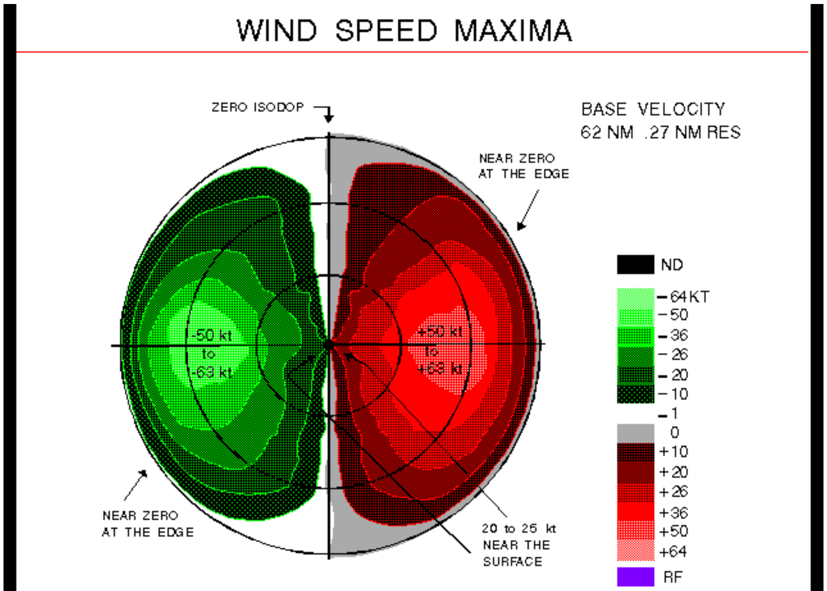


Figure 2-9. Radial velocity pattern for a wind speed maxima aloft. Note the closed isodops to the west and east of the RDA.

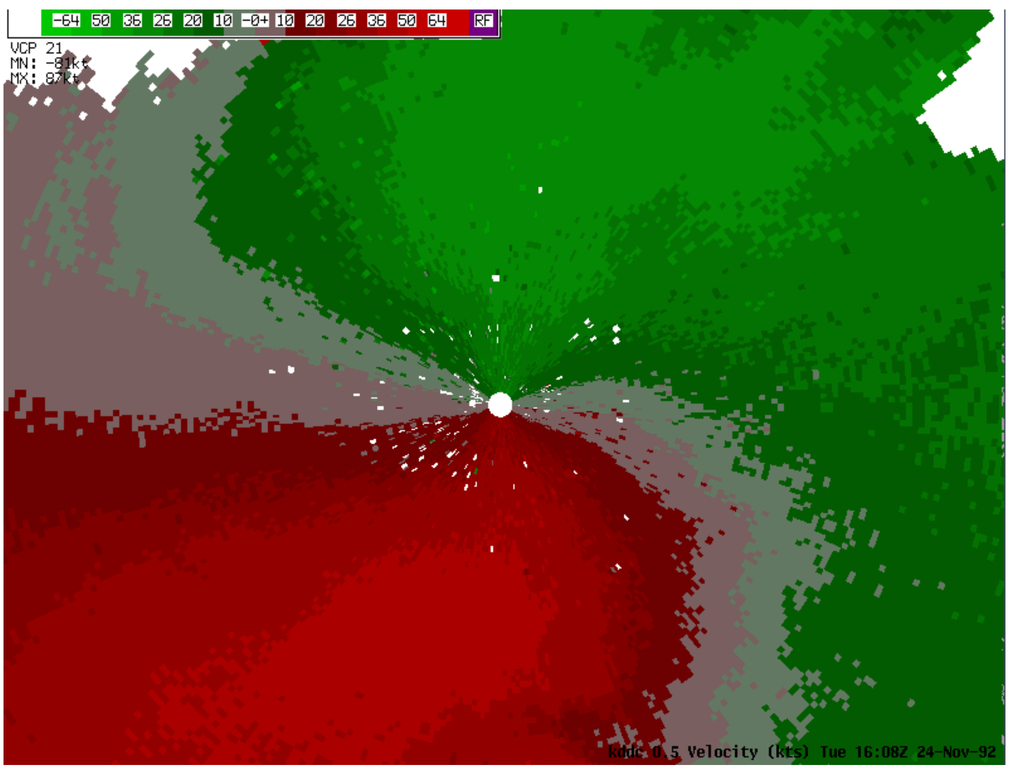


Figure 2-10. Example of a velocity maxima pattern.

"S" Shape Curvature of the zero isodop represents changing wind direction with height. Fig. 2-11 has a "S" shape to the zero isodop. The direction changes from south at the RDA, to southwest at the first range ring, to west at the edge of the display. The speed is constant at 36-49 kts from the surface up to the maximum displayed elevation. The associated vertical wind profile indicates that the winds are turning clockwise with height. The meteorological term for this is ***veering***. Veering typically indicates that warm air advection is occurring.

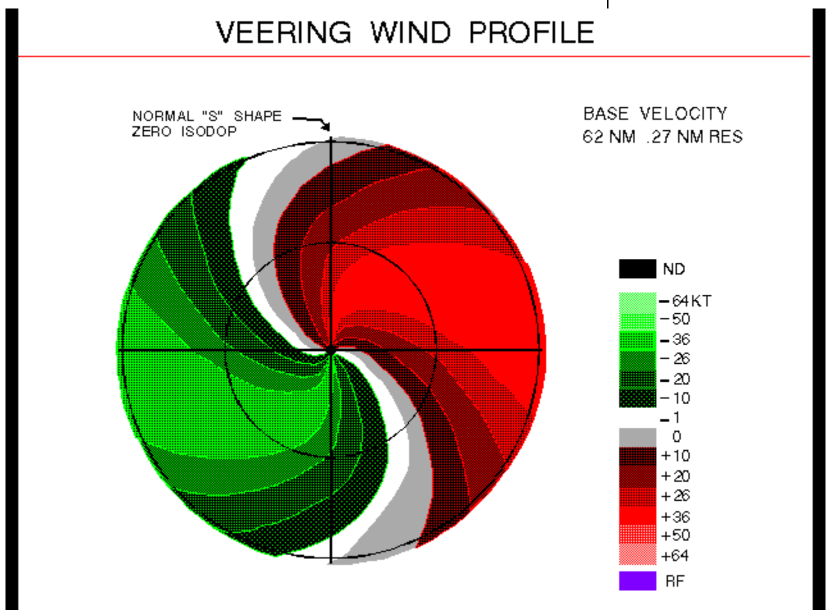


Figure 2-11. S shape zero isodop pattern indicating winds veering with height.

Fig. 2-12 is the "real world" example of veering winds with height. There is a "S" shape to the zero isodop with winds changing from north-northeast at the RDA to southeast at the edge of the display. Thus the winds are veering with height through the layer. Also note that there are wind maxima in the lower layers.

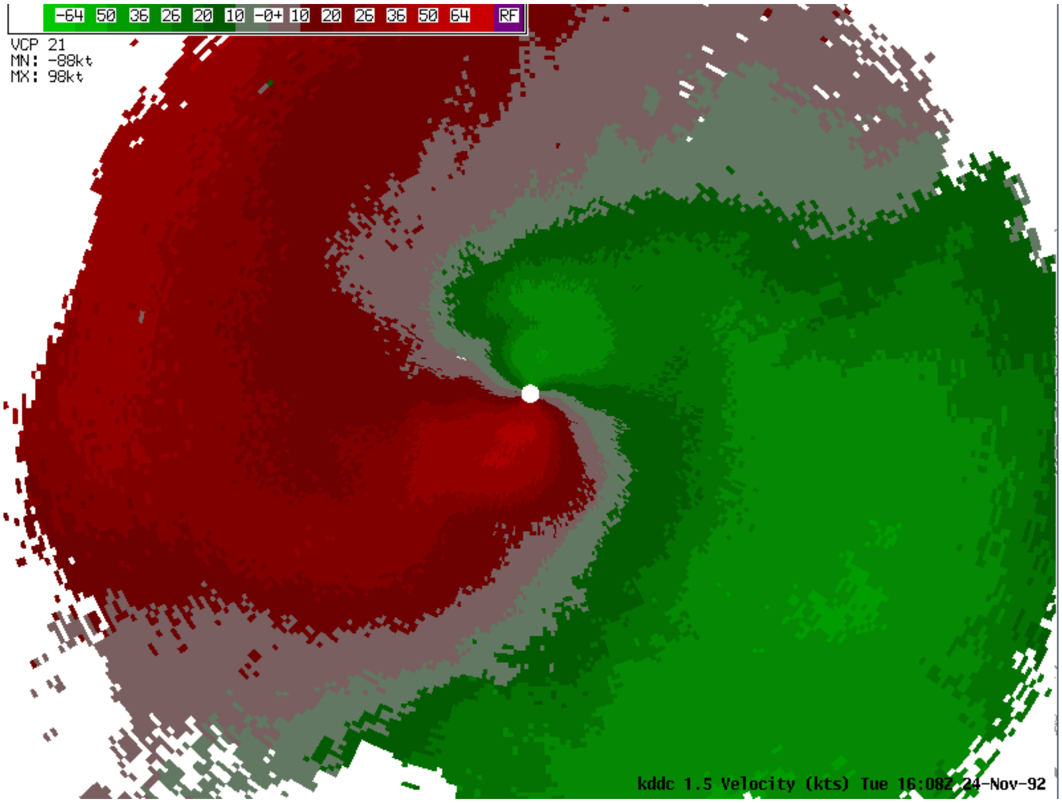


Figure 2-12. Real world S shape zero isodop pattern with wind direction veering with height.

Backward "S" Shape

In Fig. 2-13 the zero isodop shows some curvature indicating a change in the direction with height. The velocity is from the south at the RDA, from the southeast at the first range ring, and from the east at the edge of the display. The vertical wind profile indicates winds turning counterclockwise from the surface up to the maximum displayed elevation. This is termed ***backing*** which usually indicates cold air advection.

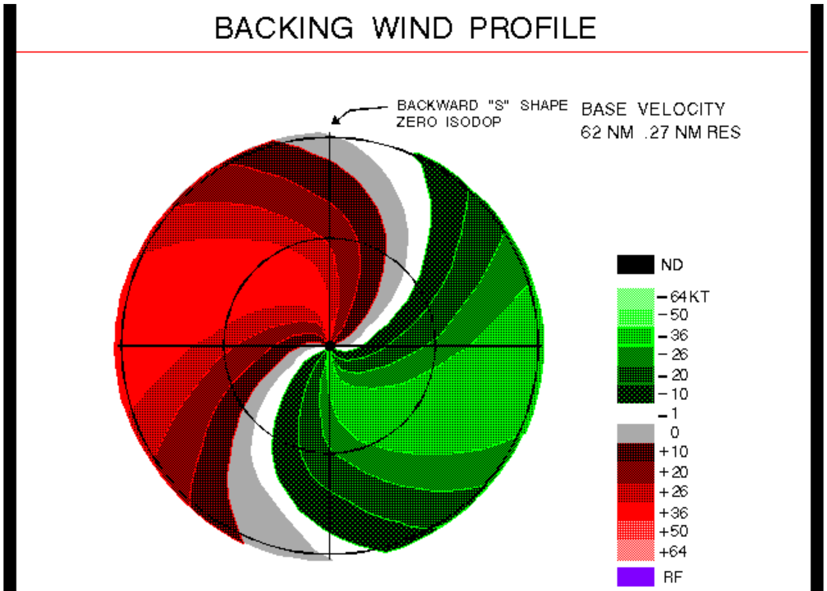


Figure 2-13. Backward S shape zero isodop pattern indicating winds backing with height

For the following questions, an image will be displayed during the teletraining presentation.	**Response Items**
At location “A”, the wind direction is from the A. south B. east C. west	Response Item 1
At location “B”, the wind is from the south at ____ knots. A. 0 to 9 B. 10 to 19 C. 50 to 63	Response Item 2
The depicted flow pattern on the screen is an indication of A. neutral temperature advection. B. atmospheric instability.	Response Item 3

C. cold air advection in the low levels and warm air advection in the upper levels.

Diffluence

In Fig. 2-14 the horizontal winds are diffluent at all levels. It is probably easier to interpret this by splitting the display into two parts: the top half and the bottom half. In the top half, the direction changes from west at the surface to southwesterly at the edge of the display. In the bottom half, the direction changes from west at the surface to northwest at the edge of the display. The associated pattern shows the air spreading out as it passes over the RDA. Note that the zero isodop has a "bowed" shape and that the ***inbound*** velocities are inside the bow.

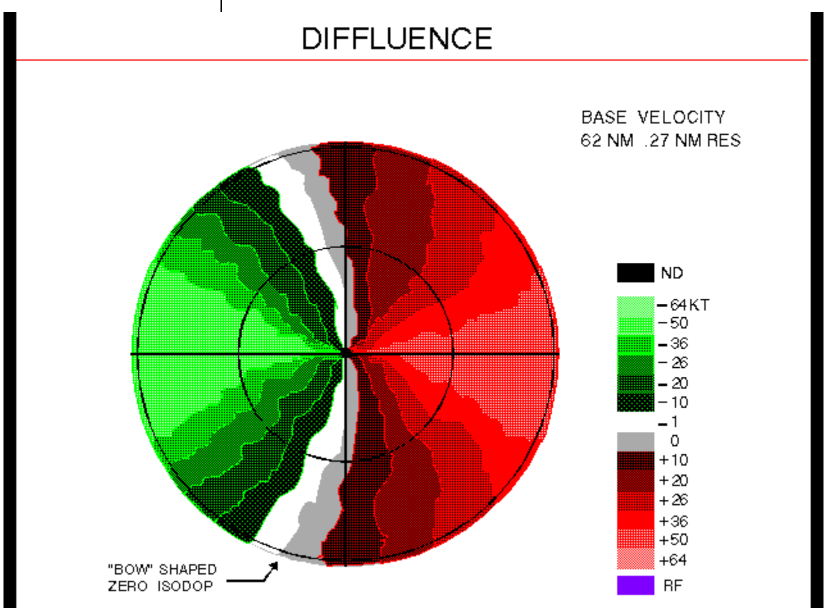


Figure 2-14. A diffluent pattern with the bowed shape zero isodop and the inbound velocities inside the bow.

Confluence

In Fig. 2-15 the flow is confluent at all levels. Notice that the ***outbound*** velocities are on the inside of the "bowed" shape of the zero isodop.

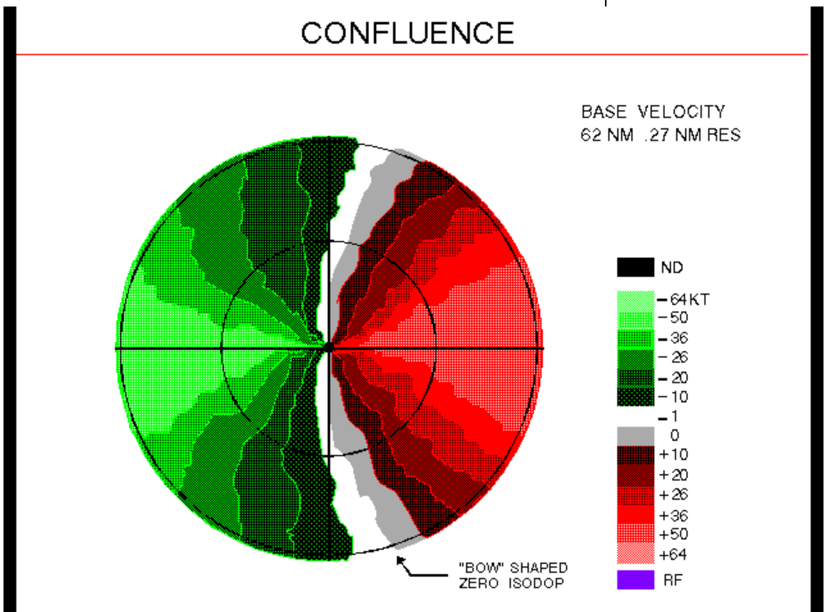


Figure 2-15. A confluent pattern with the bowed shape zero isodop and the outbound velocities inside the bow.

Sloping Wind Maxima

Fig. 2-16 has winds moving from southwest to northeast across the display. Notice the location of the maxima. The inbound maximum is between the first and second range rings, while the outbound maximum is between the second and third range rings. This indicates that the wind max is increasing in height as it moves across the display.

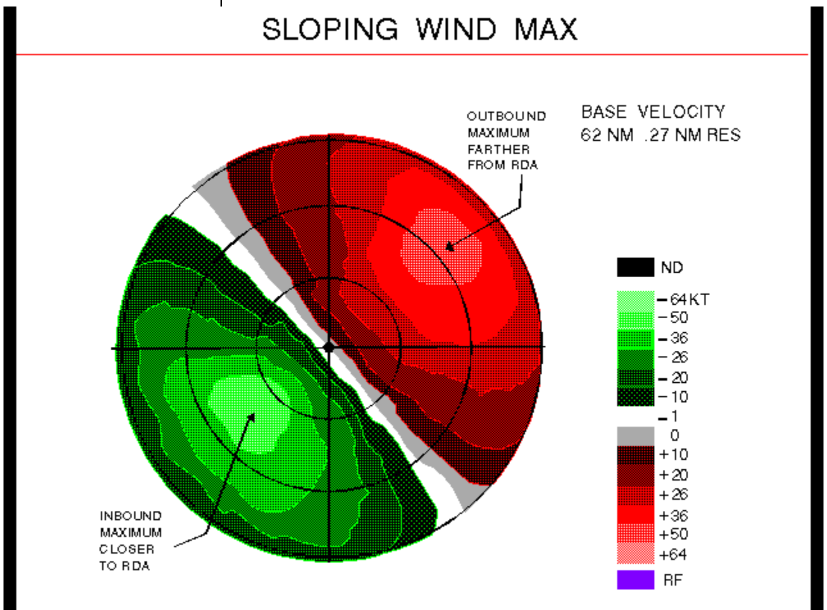


Figure 2-16. Radial velocity pattern for a sloping wind maxima. Note that the inbound and outbound maxima are at different ranges from the RDA, thus are at different heights.

Interim Summary

When looking at a display, you are looking into a cone with north at the top of the display.

The full component of the wind will be measured ***only*** when it is parallel to the radial. When the wind is perpendicular to the radial, ***none*** of the wind is measured.

Inbound velocities are negative and assigned cool colors.

Outbound velocities are positive and assigned warm colors.

A normal "S" shape zero isodop produces a clockwise turning vertical wind profile (veering), and typically indicates warm air advection.

A backward "S" shape zero isodop produces a counterclockwise turning vertical wind profile (backing), and typically indicates cold air advection.

A "bowed" shape zero isodop with inbound velocities inside the curve represents diffluence.

A "bowed" shape zero isodop with outbound velocities inside the curve represents confluence.

Horizontal Discontinuities/ Fronts

In Fig. 2-17 there is a frontal boundary located to the northwest of the RDA. Notice that the zero isodop is in a “S” shape over the southeast 2/3rds of the display. Velocity maxima are located to the southwest and to the northeast of the RDA. Behind the front, there is a maximum from the northwest. Notice that the northwest maximum does not “connect” with any other maximum.

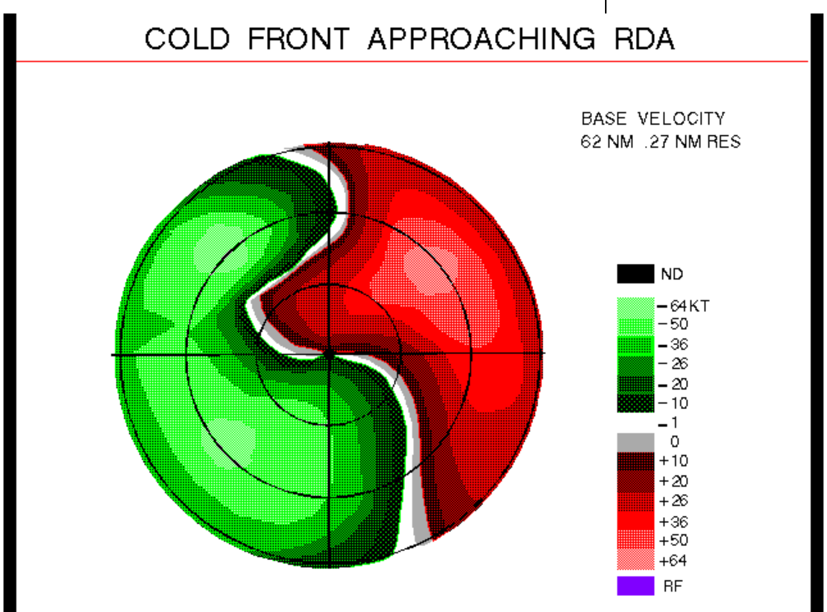


Figure 2-17. A front is located to the northwest of the RDA.

Fig. 2-18 also has a frontal boundary to the northwest of the RDA. In the real world it is not always easy to see frontal boundaries, especially in just one volume scan. (try using the loop function) Ahead of the front the inbound velocities are from the south-southwest. These correspond with the outbound velocities (and range folding) over the northern half of the display. The location of the front can be found along the cutoff between inbound velocities to the northwest of the RDA and outbound velocities to the north of the RDA. Note that this boundary is aloft.

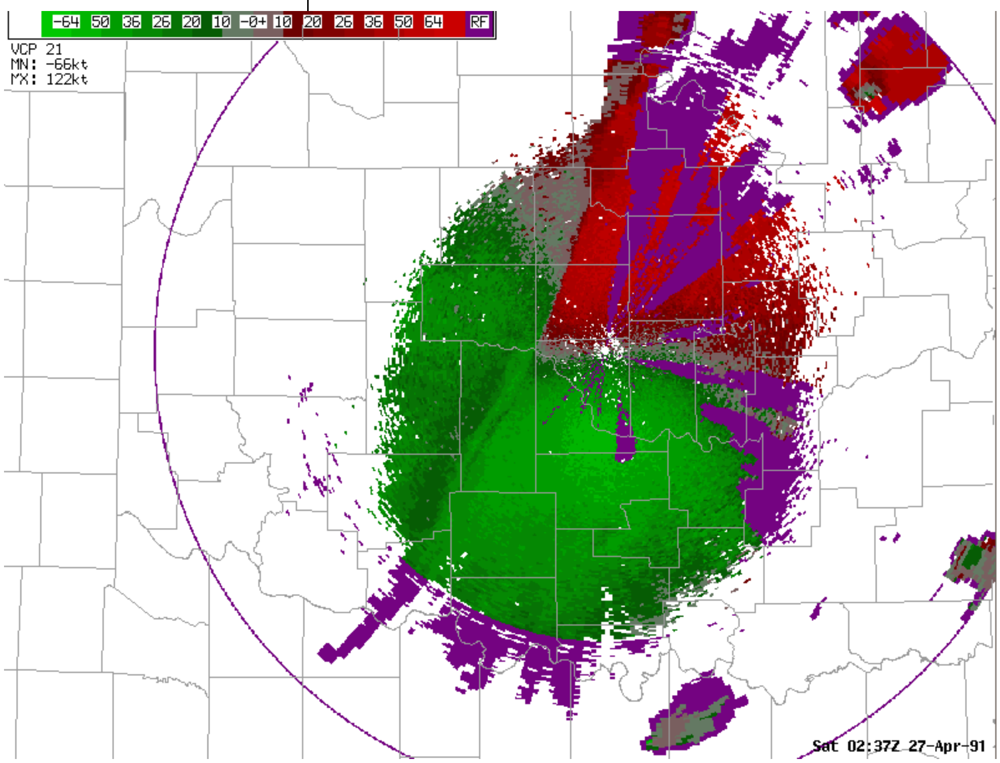


Figure 2-18. Example of a front to the northwest of the RDA.

In Fig. 2-19 the frontal boundary is now located from southwest to northeast across the RDA. Winds are from the northwest behind the front and from the southwest ahead of the front.

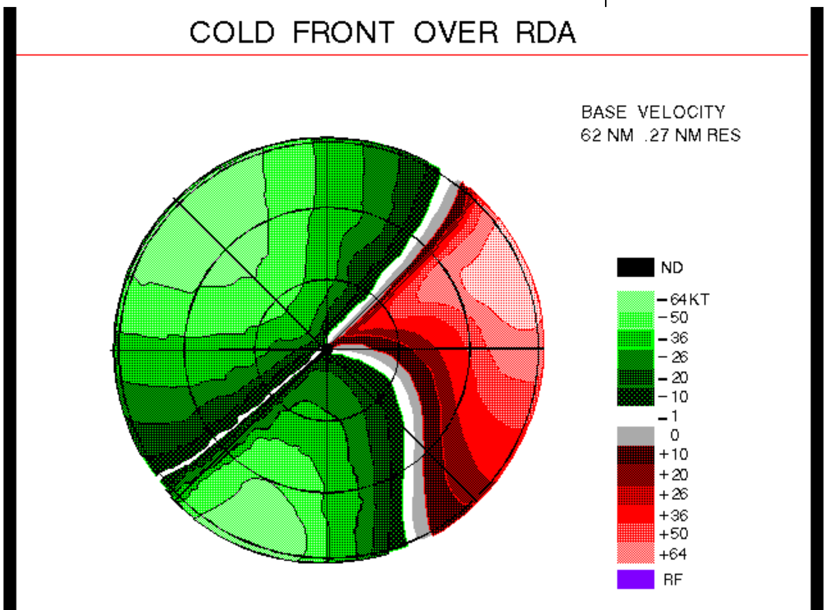


Figure 2-19. A front is located over the RDA.

Fig. 2-20 has the frontal boundary located near the RDA. Inbound velocities are located to the south and west of the RDA. A sharp change in speeds indicates the location of the boundary.

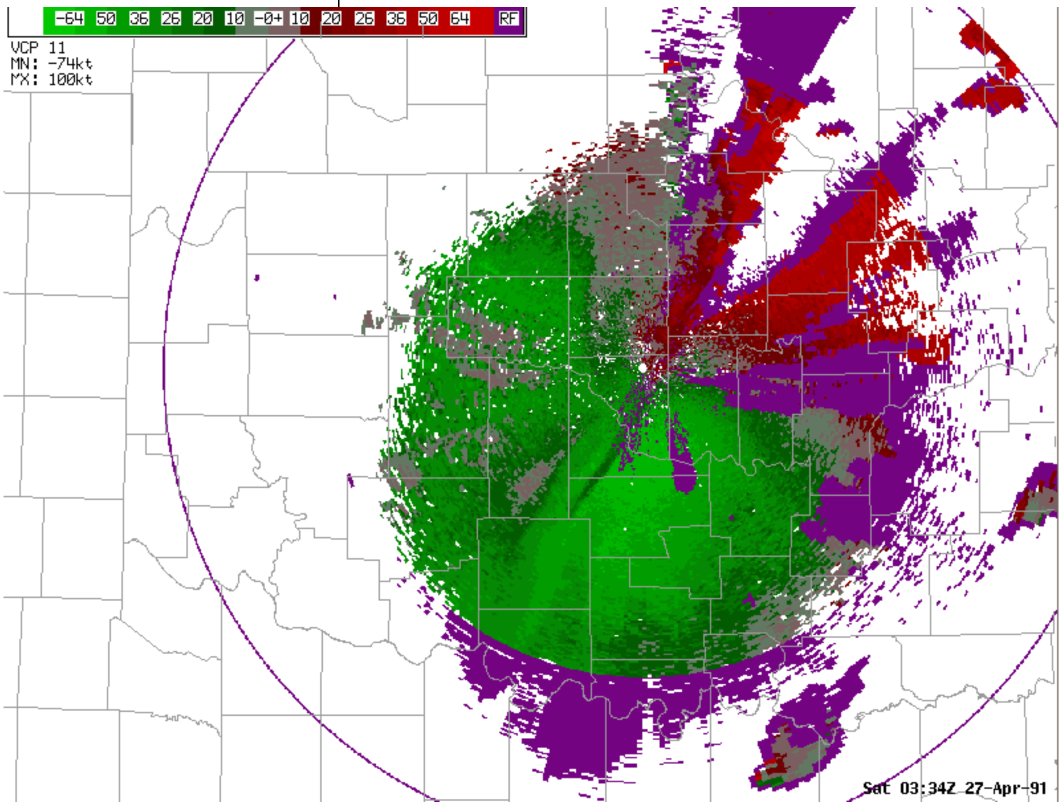


Figure 2-20. Example of a front over the RDA.

In Fig. 2-21 the front is now located southeast of the RDA. The winds ahead of the front (southeast third of display) are veering (slight "S" shape to zero isodop). The front is located along the straight line of the zero isodop and continues to the northeast quadrant of the display. Behind the front the winds are backing.

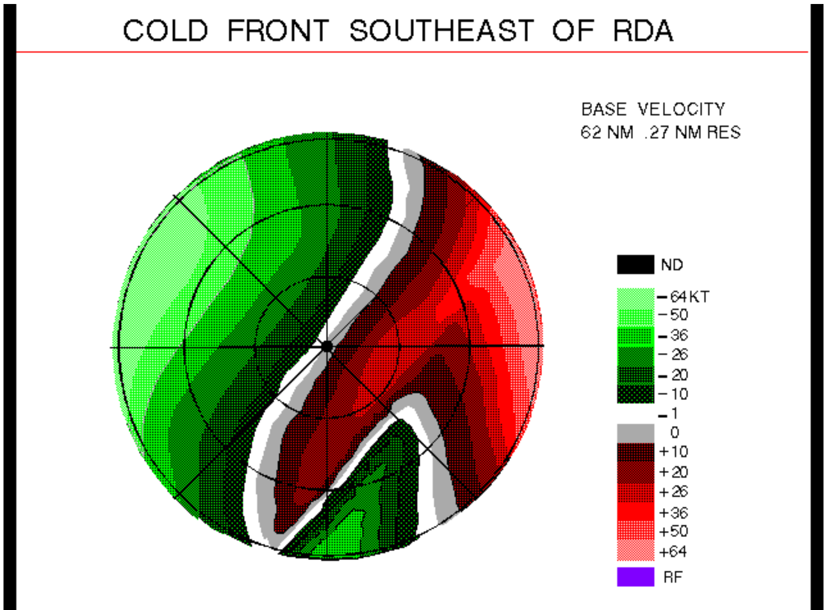


Figure 2-21. A front is located to the southeast of the RDA.

Fig. 2-22 depicts the front as located along the leading edge of outbound velocities to the east of the RDA. The front then trails in a straight line southwest across the display.

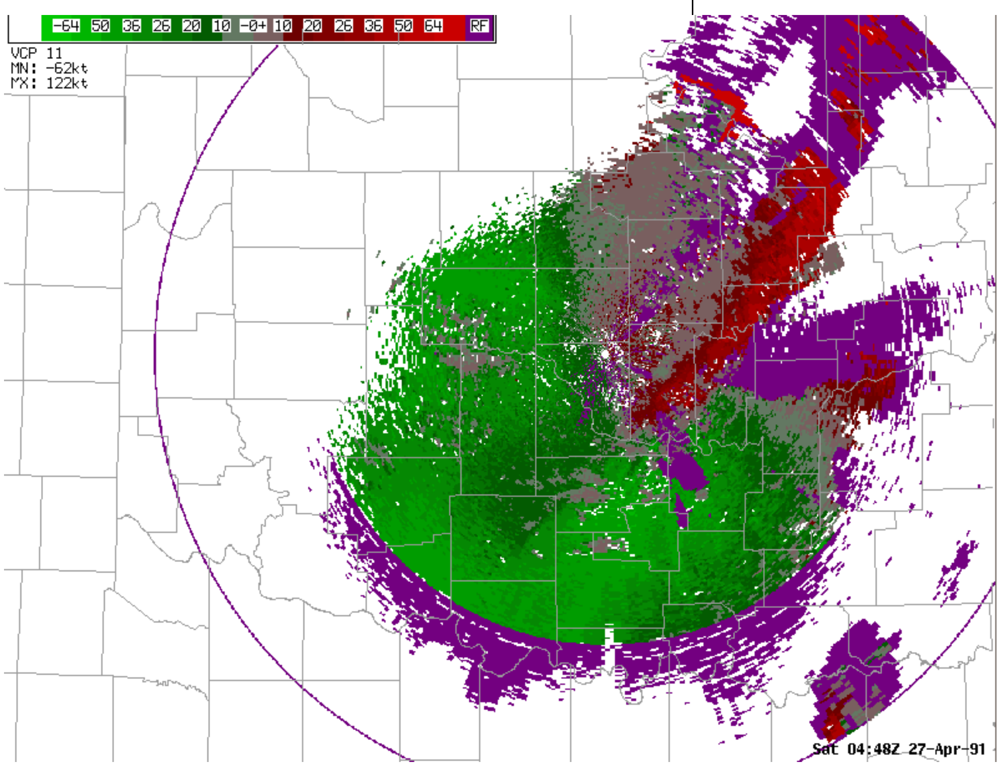


Figure 2-22. Example of a front to the east of the RDA.

Interpreting Small Scale Velocity Patterns

In the velocity examples so far, we have examined the large scale systems. This next section will deal with small scale phenomena which are only a few range gates large and therefore have a relatively small change in elevation.

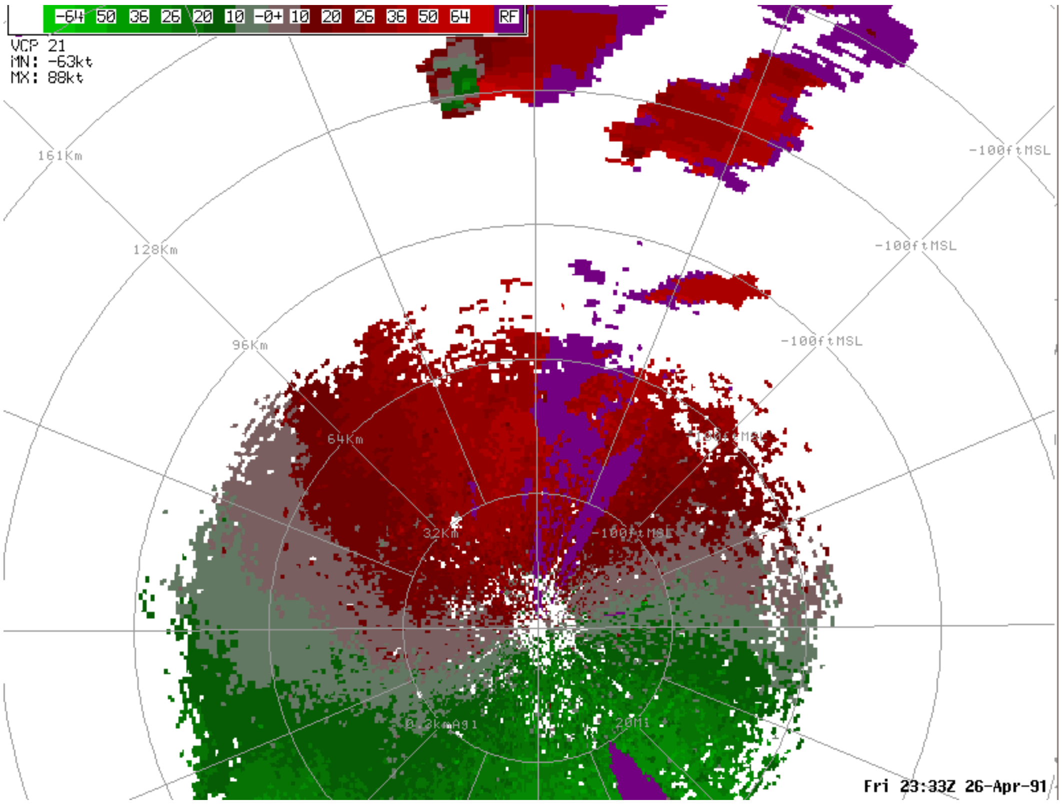


Figure 2-23. Small vs large scale velocity patterns. Note the large scale zero isodop pattern near the RDA and the individual storm to the north.

Locating the RDA

When examining data on this scale, the operator will be using the ZOOM feature in order to see small scale rotation and/or convergence and divergence. ***It is critical to know where the phenomena is in relation to the RDA.*** The operator can no longer assume that the RDA is in the center of the display, or on the display at all. The following three points used separately or in combination will help in locating the RDA.

Range Ring Map

Selecting the Range Ring Map on a velocity product will help determine the location of the RDA by overlaying a polar grid centered on the RDA.

Cursor Readout

Place the cursor at the point of interest and left click. The Cursor Readout will give the azimuth and range (in statute miles) from the RDA. (make sure it is not set to Home)

Range Gates

Range Gates increase in width along each radial as they increase in distance from the RDA.

Divergence/Convergence

When interpreting pure divergence or convergence patterns, the velocity maxima lie along the same radial. Whether the pattern is divergent or convergent is dependent on which maximum is closest to the RDA. Note that in the following examples, the RDA is located to the south of the product.

Convergence

Velocity maxima lie along the same radial with the ***outbound*** max closest to the RDA. (Fig. 2-24)

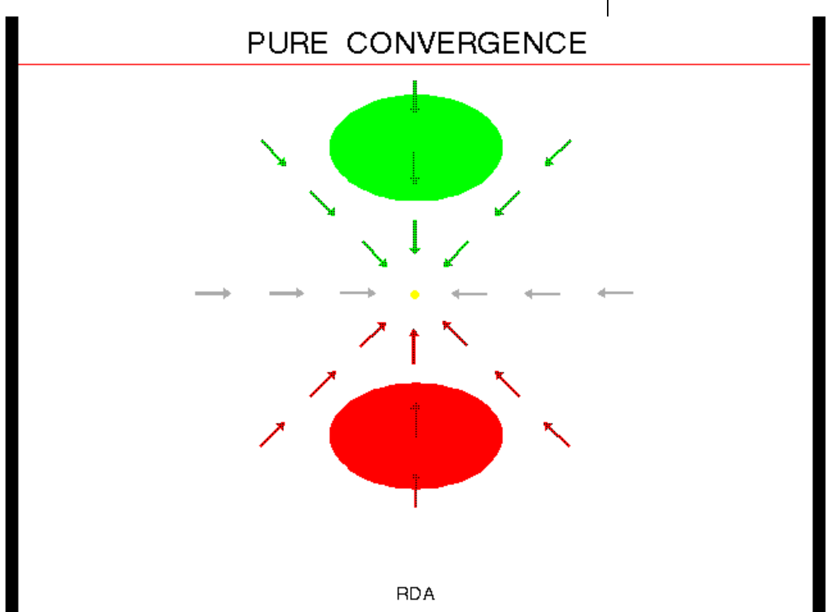


Figure 2-24. Orientation of the inbound/outbound maxima for pure convergence. Note the location of the RDA.

Divergence Velocity maxima lie along the same radial with the ***inbound*** max closest to the RDA. (Fig. 2-25)

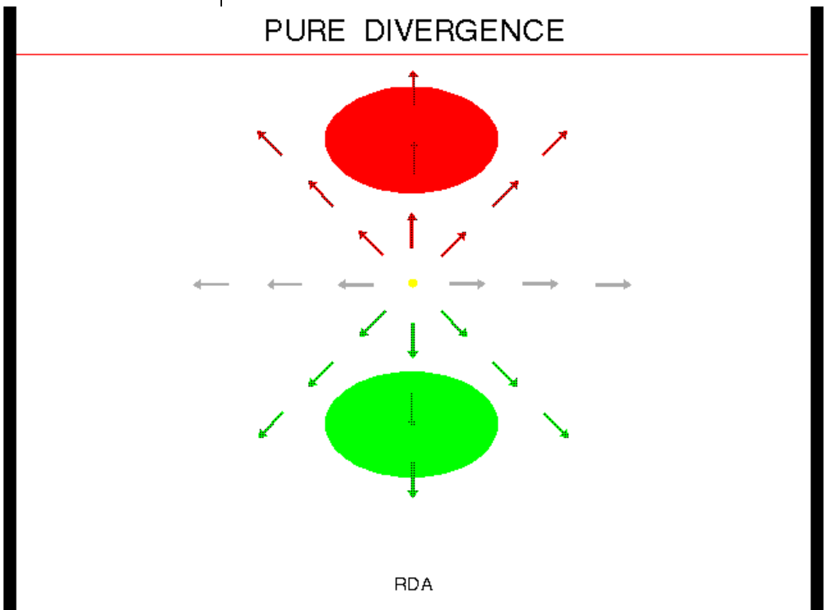


Figure 2-25. Orientation of the inbound/outbound maxima for pure divergence. Note the location of the RDA.

Rotation When interpreting pure rotation patterns, the velocity maxima are equidistant from the radar. Whether the pattern is cyclonic or anticyclonic is dependent on whether the inbound maximum is on the left or the right side. Note that in the following examples, the RDA is located to the south of the product.

Cyclonic Rotation

With the velocity maxima equidistant, the inbound maximum is ***on the left*** as seen from the RDA. (Fig. 2-26)

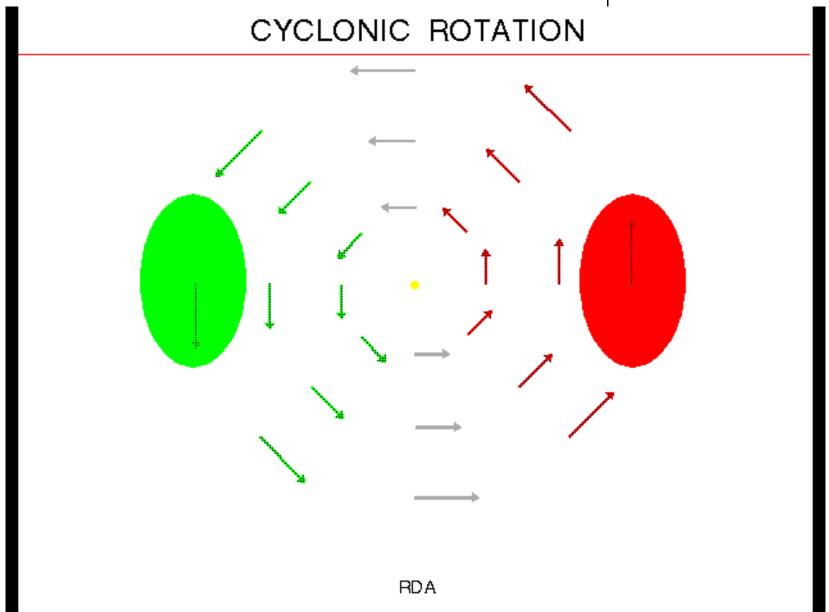


Figure 2-26. Orientation of the inbound/outbound maxima for pure cyclonic rotation. Note the location of the RDA

Anticyclonic Rotation

With the velocity maxima equidistant, the inbound maximum is ***on the right*** as seen from the RDA. (Fig. 2-27)

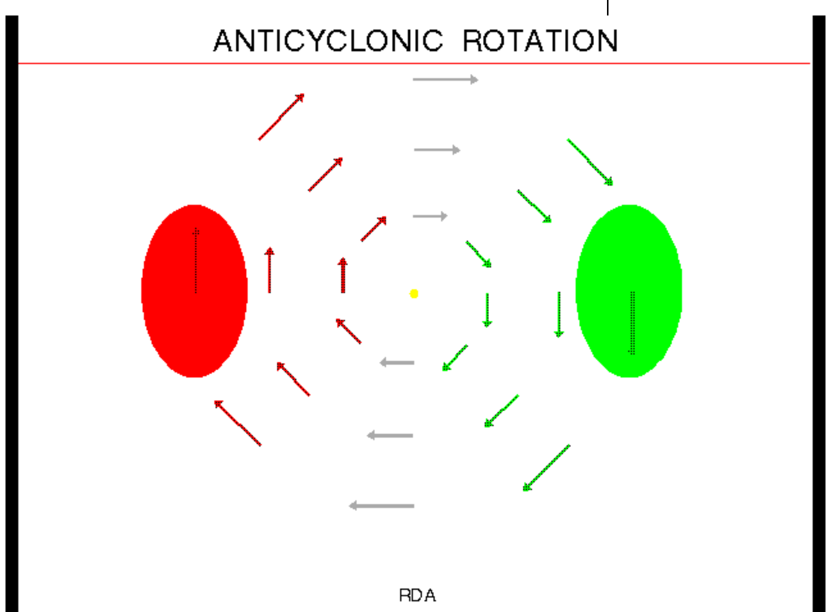


Figure 2-27. Orientation of the inbound/outbound maxima for pure anticyclonic rotation. Note the location of the RDA

Combinations

In the following examples, the RDA is located to the south of the product. The orientation of the velocity maxima from the perspective of the RDA determines convergence or divergance and cyclonic or anticyclonic rotation. In the following examples, the velocity maxima are neither along the same radial nor are they equidistant from the RDA.

Cyclonic Convergence

In Fig. 2-28, the outbound maximum is closest to the radar (convergence) and the inbound maximum is to the left as seen from the RDA (cyclonic).

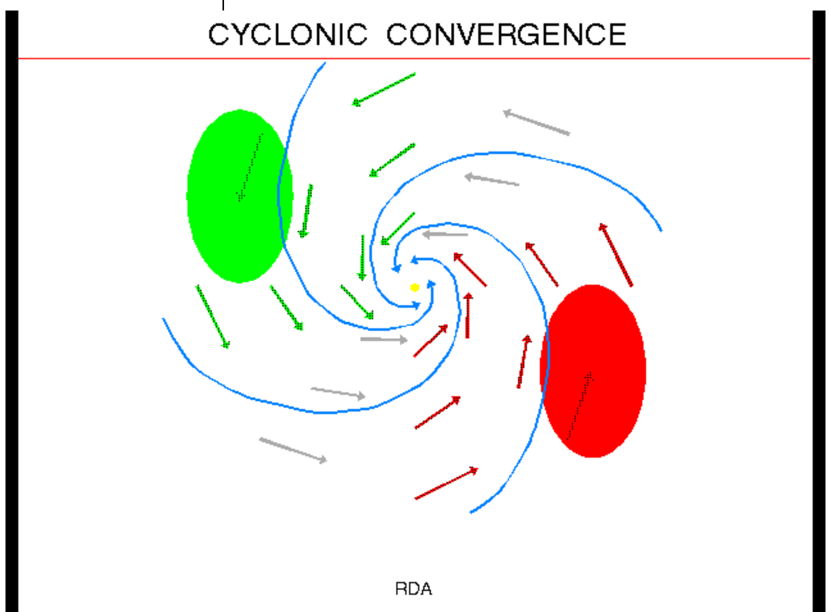


Figure 2-28. Orientation of the inbound/outbound maxima for cyclonic convergence. Note the location of the RDA

Anticyclonic Convergence

In Fig. 2-29, the outbound maximum is closest to the radar (convergence) and the inbound maximum is to the right as seen from the RDA (anticyclonic).

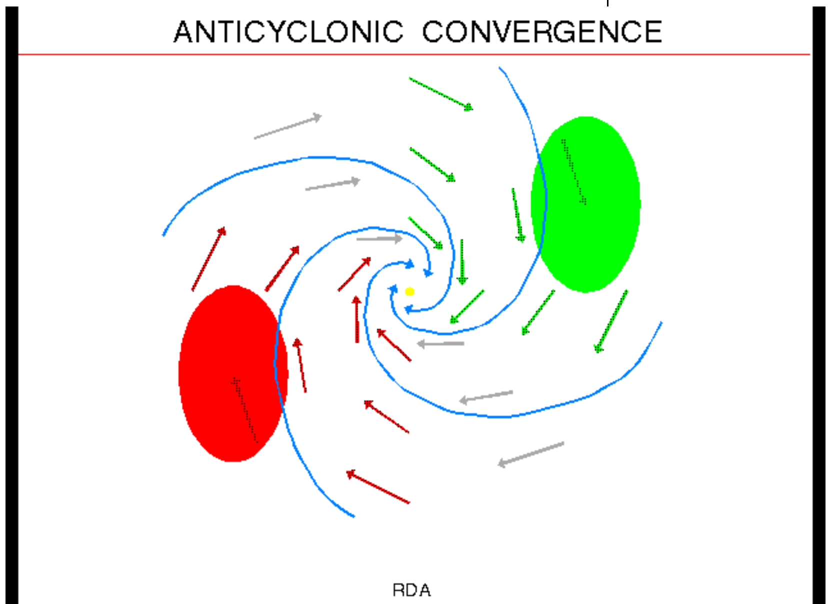


Figure 2-29. Orientation of the inbound/outbound maxima for anticyclonic convergence. Note the location of the RDA

Cyclonic Divergence

In Fig. 2-30, the inbound max is closest to the radar (divergence) and the inbound max is to the left as seen from the RDA (cyclonic).

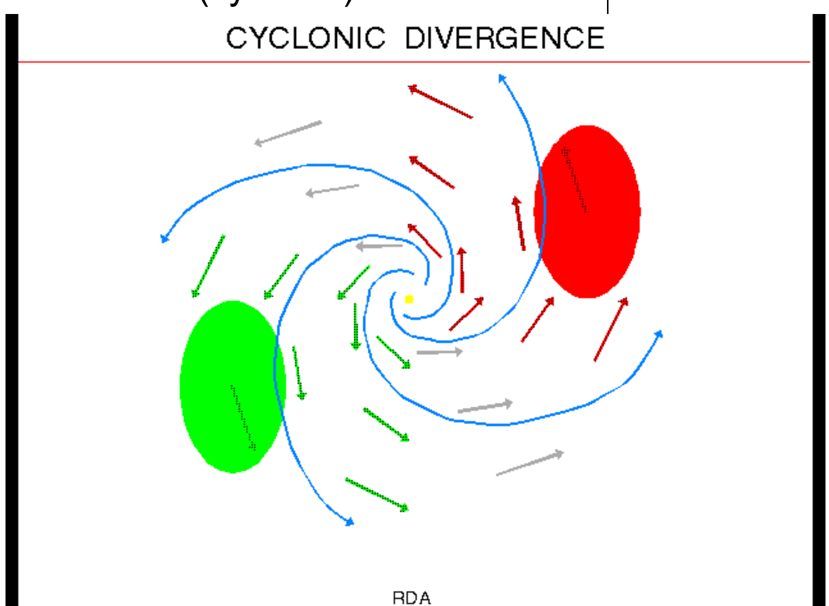


Figure 2-30. Orientation of the inbound/outbound maxima for cyclonic divergence. Note the location of the RDA

Anticyclonic Divergence

In Fig. 2-31, the inbound max is closest to the radar (divergence) and the inbound max is to the right as seen from the RDA (anticyclonic).

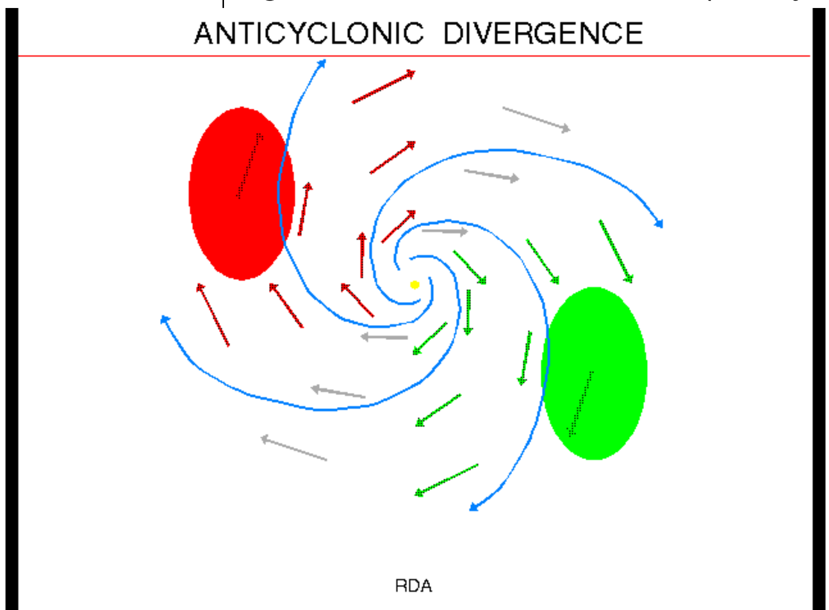


Figure 2-31. Orientation of the inbound/outbound maxima for anticyclonic divergence. Note the location of the RDA

Cyclonic Rotation - Real Time

In Fig. 2-32, the RDA is to the south-southeast of each panel. Upper-left panel (0.5°) depicts cyclonic convergence, upper-right and lower-left panels are close to "pure" rotation. Lower-right panel is an example of storm top divergence. The products used in this example are Storm Relative Mean Radial Velocity Map (SRM) in which the storm motion is subtracted out from the base velocity in order to see the rotation. The SRM will be covered in detail in I.C. 5.5, Derived Products.

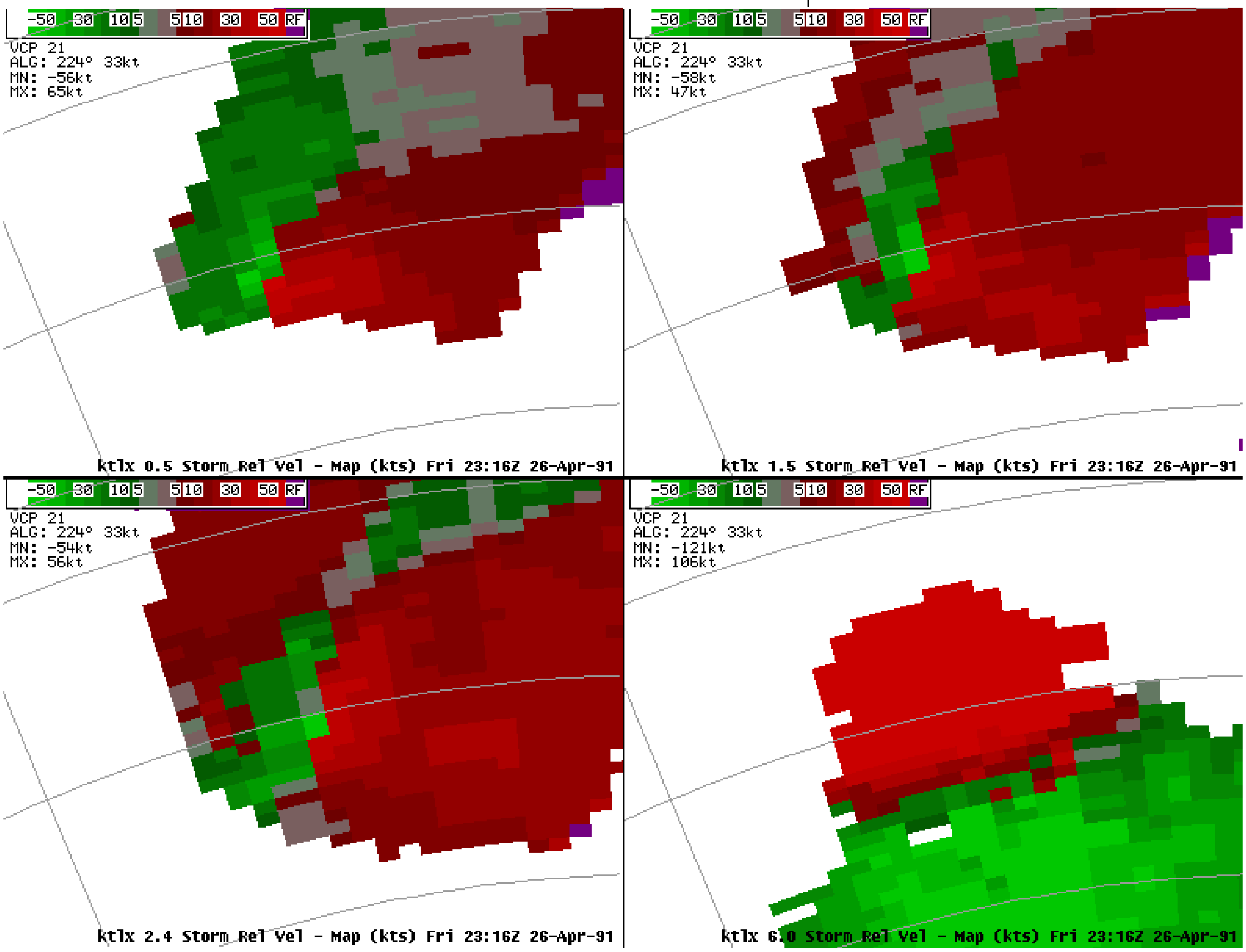


Figure 2-32. Four quadrant display of different elevation angles through a storm. Note that the RDA is to the south of the display and that the small scale features change with height.

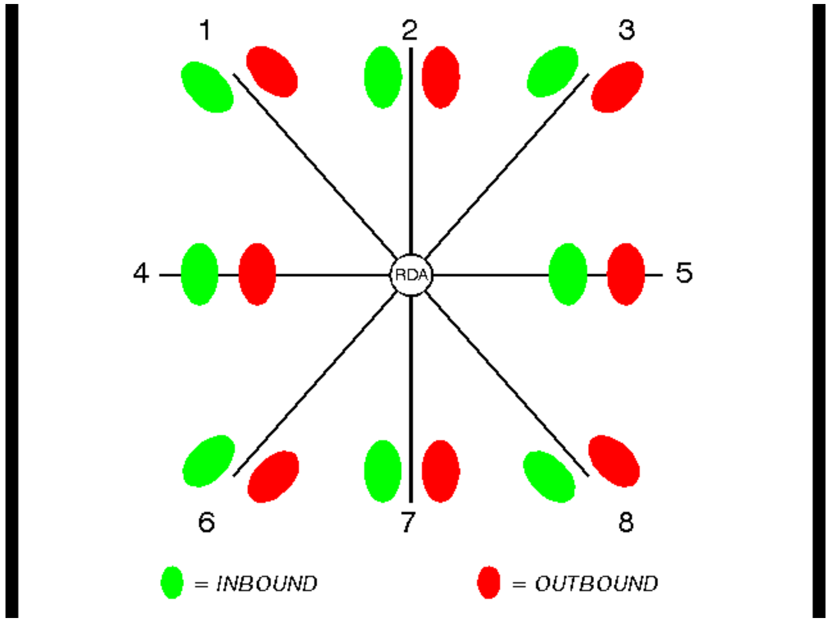


Figure 2-33. Example of how the small scale features change as the radar radial changes.

Interim Summary

Convergence	The velocity maxima lie along the same radial, with the outbound maximum closest to the radar
Divergence	The velocity maxima lie along the same radial, with the inbound maximum closest to the radar
Cyclonic Rotation	The velocity maxima are equidistant from the radar, with the inbound maximum to the left as seen from the radar
Anticyclonic Rotation	The velocity maxima are equidistant from the radar, with the inbound maximum to the right as seen from the radar

08/02

SUMMARY
OF
LIMITATIONS/STRENGTHS/APPLICATIONS

(These are from those found in the student guide and are provided here for your convenience.)

Base Products

Base Reflectivity (R)

Limitations

1. Users are unable to edit the data level values.
2. Weak returns are not displayed in Precipitation Mode.

Strengths and Applications

1. Users have the ability to determine intensity of precipitation echoes, movement and trends.
2. Clear Air Mode allows weak precipitation returns to be displayed (such as light rain or snow) down to -28dBZ.
3. Non-precipitation phenomena can also be observed.

8-bit Reflectivity (8-bit REF)

Limitation

1. Users are unable to edit the data level values

Strengths and Applications

1. Users have the ability to determine intensity of precipitation echoes, movement and trends.
2. All 8-bit Reflectivity products allow weak precipitation returns to be displayed (such as light rain or snow) down to -30dBZ.
3. Non-precipitation phenomena can also be observed
4. .54 nm resolution out to 248 nm vs. 124 nm on the Base Reflectivity products.
5. 256 data levels (-30 dBZ to >90 dBZ) vs. 16 or 8 data levels on the Base Reflectivity products.

Base Velocity (V)

Limitations

1. Velocity data can be obscured by range folding.
2. Incorrect velocity dealiasing can contaminate velocity data.

Strengths and Applications

1. Base Velocity is used to determine the magnitude of radial velocities.
2. Environmental wind flow can be observed.
3. Storm structure features can be identified.
4. Use to create or adjust hodographs.

8-bit Velocity (8-bit VEL)

Limitations

1. Velocity data may be obscured by range folding.
2. Incorrect velocity dealiasing can contaminate velocity data.

Strengths and Applications

1. .13 nm resolution out to 124 nm vs. 32 nm on the Base Velocity products.
2. Base Velocity is used to determine the magnitude of radial velocities.
3. Environmental wind flow can be observed.
4. Storm structure features can be identified.
5. Use to create or adjust hodographs.
6. 256 data levels (-100 kts to +100 kts) vs. 16 or 8 data levels on the Base Velocity products.

Base Spectrum Width (SW)

Limitations

1. Base Spectrum Width data can be obscured by range folding.
2. High or erratic values are possible due to movement of ground clutter or system noise.
3. Base Spectrum Width is hindered by a longer narrowband transmission time.

Strengths and Applications

1. Base Spectrum Width is useful in evaluating the reliability of Base Velocity Data

All Base Products

Limitations

1.Ground clutter can contaminate all products.
2. Beam blockage can be a problem especially on lower elevations.
3. Beam broadening will cause worse resolution at longer ranges.
4. The effects of the earth's curvature will cause the radar to overshoot low level features at long ranges.
5. Discrete elevation sampling may cause some echoes to be poorly sampled, especially in VCP 21 at close ranges.
6. There will be a lack of data in the cone of silence.
7. Chaff returns will contaminate products.

Strengths and Applications

1. Use products to evaluate environmental conditions and meteorological characteristics.
2. Can be used to identify cloud layers and precipitation characteristics.
3. Regardless of VCP, the products can be used to identify location and motion of troughs, fronts and other boundaries.
4. Locate and identify the melting level.
5. When used together, they are especially useful at identifying severe storm signatures.
6. Identify non-meteorological phenomena.
7. Locate suspected areas of turbulence and shear regions.

08/02

Review Exercise
IC 5.4 Base Products
(includes 8-bit Reflectivity and Velocity)

1. For **All** Base products, which of the following is/are **Not** (a) limitation(s)?
   a) Residual Clutter and Ground Returns
   b) Resolution vs Range
   c) Determine Significant Storm Structure Features
   d) Effects of Discrete Elevation Sampling
   e) Cone of Silence

2. Which of these statements concerning Base Reflectivity and 8-bit Reflectivity products is/are true?
   a) Clouds will be observed only in clear air mode.
   b) Best available resolution is .13 nm.
   c) Reflectivity data level values can be changed at the RPG HCI.
   d) Base Reflectivity products generated in Clear Air mode and 8-bit Reflectivity products are best for examining boundaries.

3. **True/False** Forest fires, chaff and other non-meteorological phenomena will be observed on the Base Reflectivity product at times, but only while operating in precipitation mode.

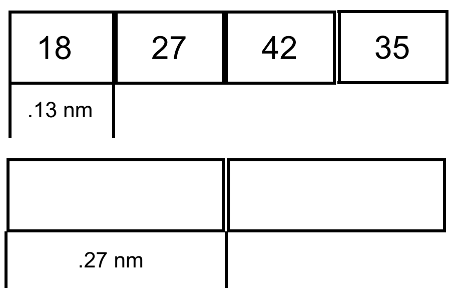
4. To over come the limitation of Range Folding the radar operator can:
   a) Adjust the PRF
   b) Invoke Clutter Suppression
   c) Select a higher elevation slice
   d) Dial-in to another radar site

5. Which of these statements concerning Base Velocity and 8-bit Velocity products is/are true?
   a) Range folding may obscure data at times.
   b) On Base Velocity .13 nm resolution product range is 32 nm, while the 8-bit Reflectivity .13 nm resolution product range is 124 nm.
   c) Velocities will not be improperly dealiased, except around strong mesocyclones and TVSs.
   d) The product is useful in estimating ground relative wind speeds.

6. A bow echo is observed 35 nm west of the RDA and is moving east. You are investigating Base Velocity/8-bit Velocity products for a possible wind maximum that may produce surface straight line wind damage. However, range folding is observed on the 0.5 degree products. Of the following, which is the best action to take to display reliable velocity data?
   a) Change the velocity data levels at the RPG HCI after gaining approval through the unit radar committee.
   b) Use a 2.2 nm Base Velocity product at a higher slice.
   c) Send a one-time request for a Base Spectrum Width product
   d) Use the Base Velocity/8-bit Velocity product at a higher slice.

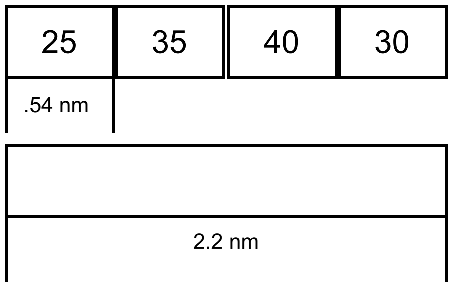
7. The Spectrum Width product can be used to:
   a) Evaluate the validity of the mean radial velocity estimates.
   b) Help locate boundaries
   c) Locate areas of suspected turbulence
   d) Detect chaff only when operating in VCP 11 and 21.
   e) Calculate rotational velocities in tornadic thunderstorms.

8. Given the following **Base Velocity** data for four successive 0.13 nm range bins, which values will be displayed in a 0.27 nm resolution **Base Velocity product**?



   a) 27 and 42
   b) 18 and 42
   c) 23 and 39
   d) 27 and 35

9. Given the following **Base Reflectivity** data for four successive 0.54 nm range bins, which values will be displayed in a 2.2 nm resolution **Base Reflectivity product?**



a) 33
b) 25
c) 30
d) 40

Review Exercise
IC 5.4 Base Products
*****ANSWER KEY*****

1. **C.** Determining Significant Storm Structure Features is a strength/application. The others are limitations.

2. **D.** Base Reflectivity products in clear air mode display returns down to -28 dBZ and 8-bit Reflectivity products display returns down to -30 dBZ. This will aid in displaying the lower reflectivities generally associated with boundaries. All the other statements are false: Clouds can be seen in precipitation mode (precipitation will start around 20 dBZ), the best resolution of base reflectivity is .54 nm, and the operator cannot edit or change the data level values at the RPG HCI.

3. **False**. Non-meteorological phenomena can be viewed in either precipitation or clear air mode.

4. **A,B,C,D**. (A) Changing the PRF changes the $R_{max,}$ possibly moving the range folding away from the area of interest. (B) Range folding may be caused by nearby ground returns that are obscuring data in the second trip. (C) By choosing a higher elevation angle, the beam may over shoot the target in the second trip. (D) The same storm may not be range folded when viewed from another radar.

5. **A,B,D**. Range folding is one of the limitations of Base/8-bit Velocity products. The best resolution for the Base Velocity and 8-bit Velocity products is .13 nm and has a range of 32 nm and 124 nm , respectively. The Base/8-bit velocity products are quite useful for finding shear. C is false...improper dealiasing can happen anywhere (if it did happen only around strong mesos and TVSs, we could use that as a warning indicator!!).

6. **D**. Changing data level values will not have an effect on range folding, so that eliminates answer “A”. There is no 2.2 nm velocity products, eliminating “B”. We are looking to identify strong winds, so we have to use a velocity product, thus eliminating answer “C”. When using a Base Velocity/8-bit Velocity product at a higher elevation slice the beam may over shoot the target in the second trip making “D” the best choice.

.

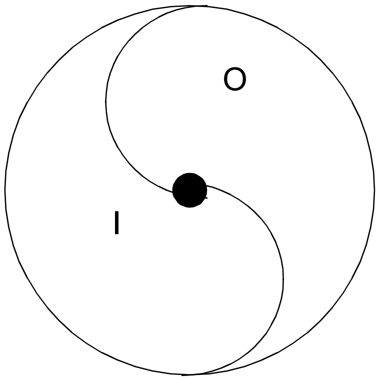
7. **A,B,C**. Spectrum Width can be used to evaluate validity of velocity estimates, locate boundaries, and locate areas of suspected turbulence. Chaff will be displayed in any VCP, so “D” is incorrect, and “E” is just nonsense.
8. **B.** Base velocity uses data from the first of two consecutive .13 nm range bins to generate the .27 nm product. Given the four consecutive .13 nm resolution range bins, the velocity data displayed on the .27 nm resolution product will come from the 1st and 3rd bins, or 18 and 42 kts.

9. **D.** In contrast to base velocity products, base reflectivity uses the highest reflectivity values when going to a lower resolution. So, for the four consecutive .54 nm range bins, the highs of the four values will be used on the 2.2 nm resolution product. The 3rd range bin is used, or 40 dBZ.

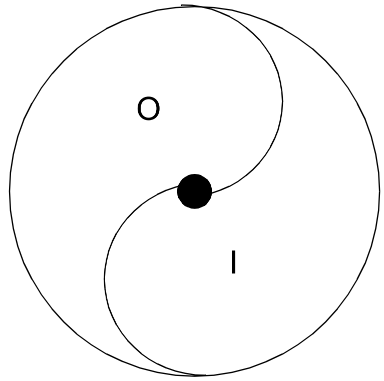
Practice Exercise #1

For each of the following examples, use the zero isodop to determine wind direction at different levels using the method presented in class. (The RDA is assumed to be at the center of each circle.)

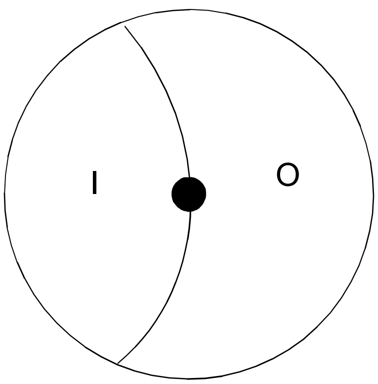
1



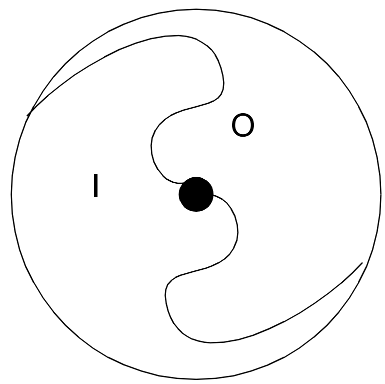
2



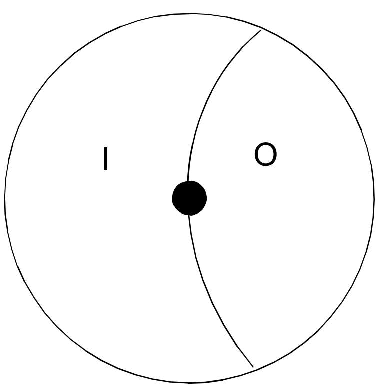
3



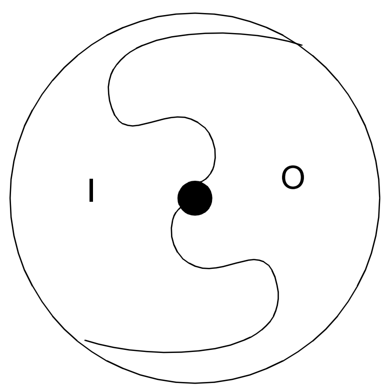
4



5

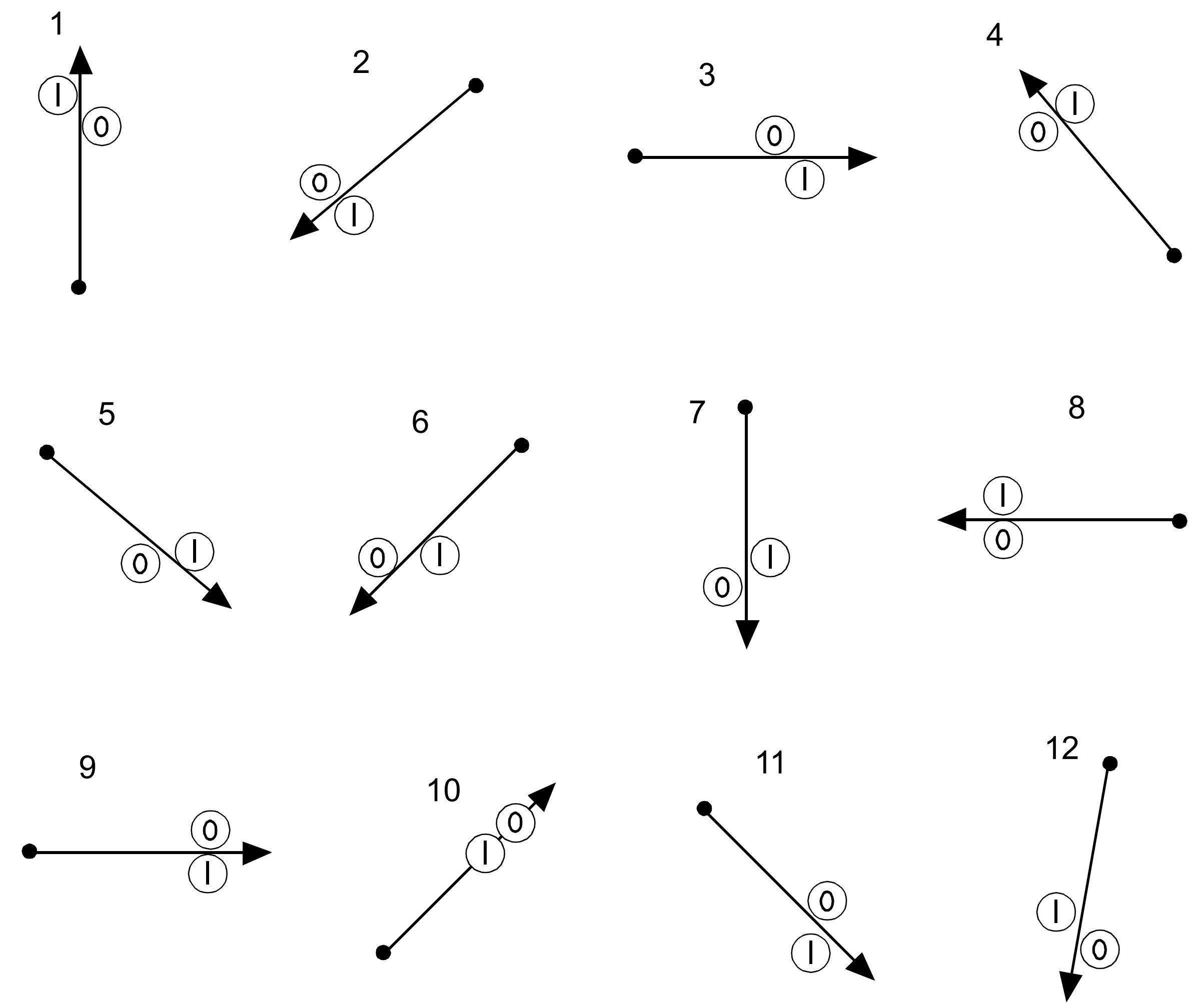


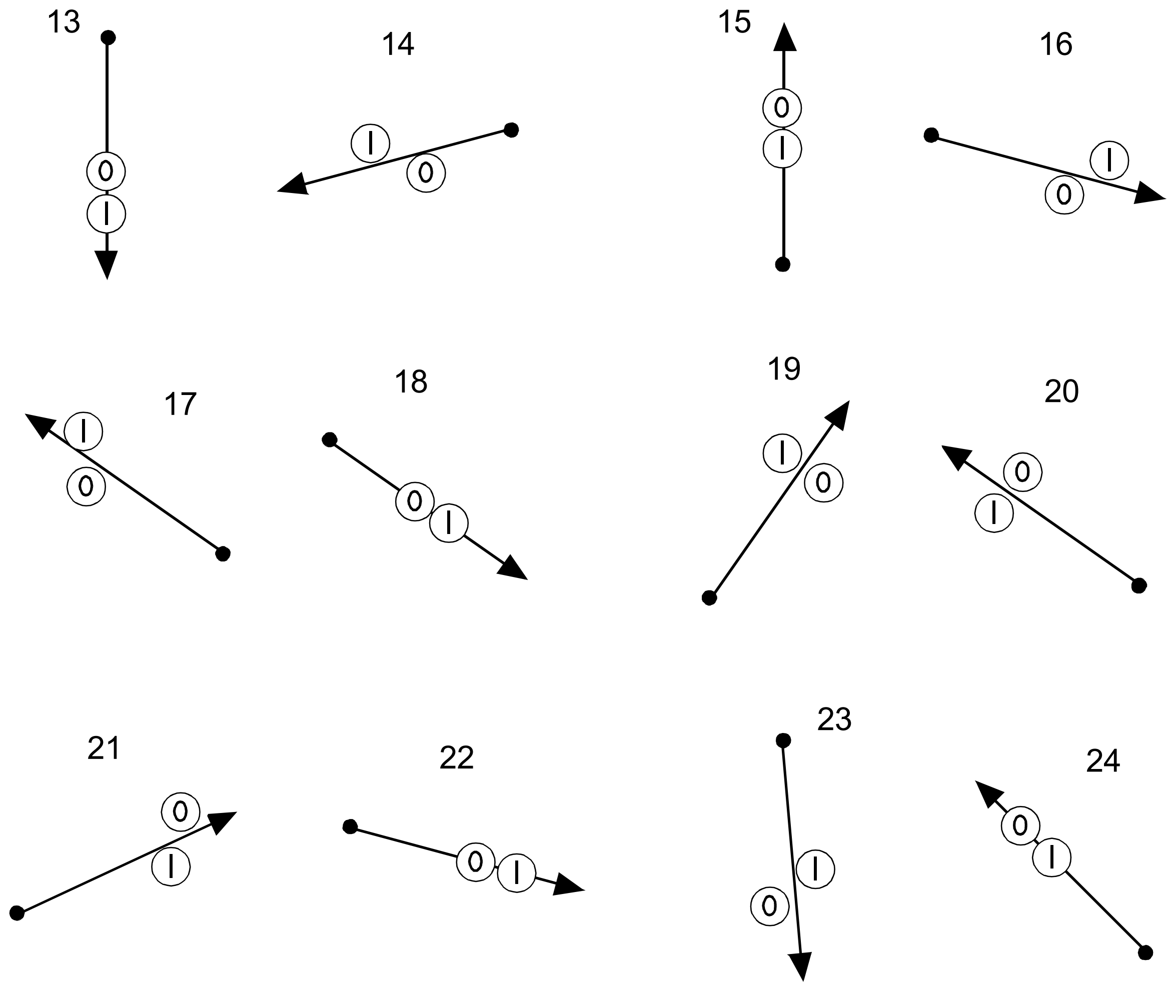
6



Practice Exercise #2

The velocity couplets below represent small scale patterns. The RDA is located at the dot at one end of the arrow and the arrow is pointed in the direction of the radar beam. The I and O represent the inbound and outbound velocity maxima, respectively. Determine the type of flow pattern and enter the initials on the following answer sheet: Pure convergence (PC), pure divergence (PD), pure cyclonic rotation (CR), pure anticyclonic rotation (AR), cyclonic divergence (CD), anticyclonic divergence (AD), cyclonic convergence (CC), or anticyclonic convergence (AC).




13
0
1
14
1
0
15
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16
1
0
17
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19
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20
0
1
21
0
1
22
0
1
23
1
0
24
0
1

Practice Exercise #2 Answer Sheet

1. ______	7. ______	13. ______	19. ______
2. ______	8. ______	14. ______	20. ______
3. ______	9. ______	15. ______	21. ______
4. ______	10. ______	16. ______	22. ______
5. ______	11. ______	17. ______	23. ______
6. ______	12. ______	18. ______	24. ______

Review Exercises - Answer Key

1. Match the wind profiles, A through D, to the Velocity products shown in Figures 1 through 4.

__3__ A

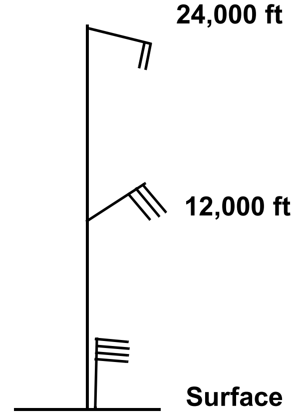
__2__ B

__4__ C

__1__ D

2. Construct a vertical wind profile to match Figure 5. (Assume the edge of the display is 24,000 ft.)

Note: This profile is an approximation. There will be variations in interpretation due to variations in the color copy quality.



3. In Figure 6, the low level wind direction is from the __north__.

4. In Figure 6, the wind direction at the edge of the display is from the south__.

5. In Figure 6, the velocity pattern suggests

b) a frontal boundary is aloft over the RDA

6. In Figure 7,

a) What is the quickest/most accurate way to obtain the AZRAN of the feature below the letter A (arrow points to center of feature) using AWIPS? **place cursor on the point of interest and hold down the left mouse button**
b) Where is the RDA relative to the display? **__southeast__**
c) The small scale feature below the letter A (arrow points to center of feature) is
2. cyclonic rotation

7. In Figure 8,

a) The small scale feature below the letter A (arrow points to center of feature) is
3. divergence

8. In Figure 9,

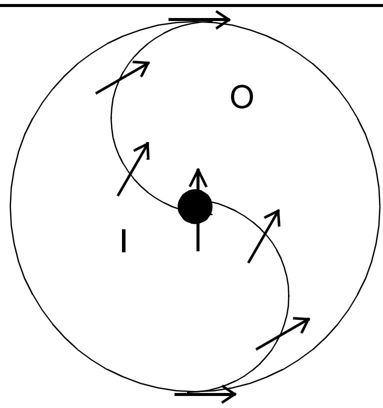
a) What is the quickest/most accurate way to obtain the elevation of the feature below the letter A (arrow points to center of feature) using AWIPS? **place cursor on the point of interest and hold down the left mouse button**
b) Where is the RDA relative to the display? **___southeast___**
c) The small scale feature below the letter A (arrow points to center of feature) is
2. anticyclonic rotation

In Figure 10,
d) The small scale feature below the letter B (arrow points to center of feature) is
1. cyclonic divergence

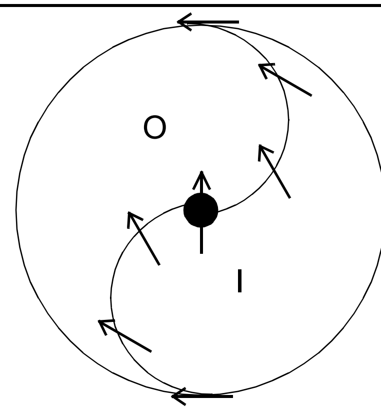
Practice Exercise #1 - Answer Key

For each of the following examples, use the zero isodop to determine wind direction at different levels using the method presented in class. (The RDA is assumed to be at the center of each circle.)

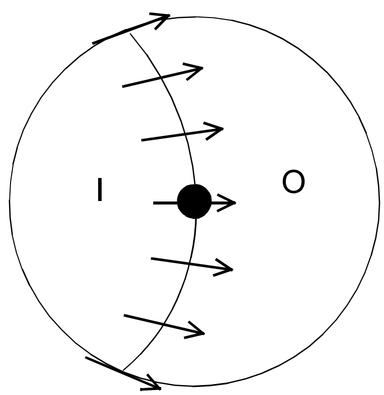
1



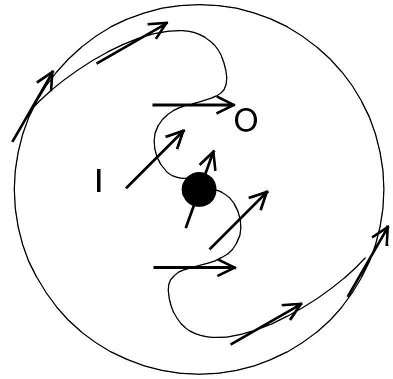
2



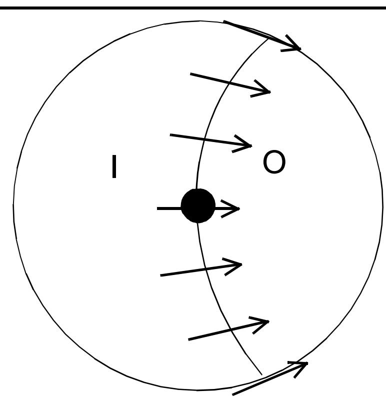
3



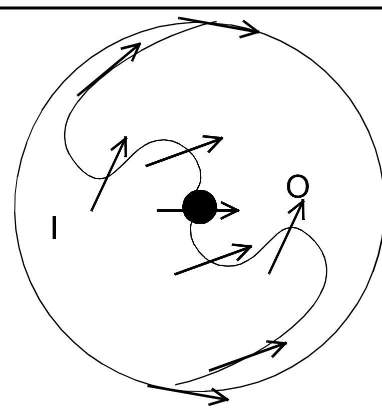
4



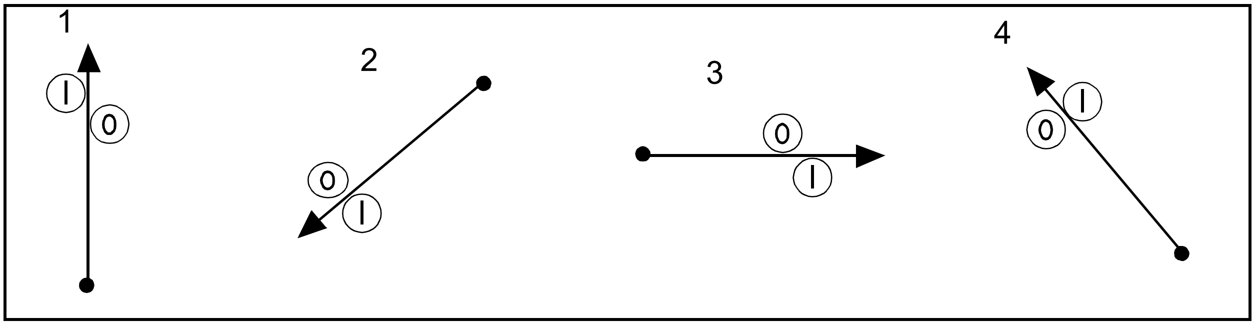
5



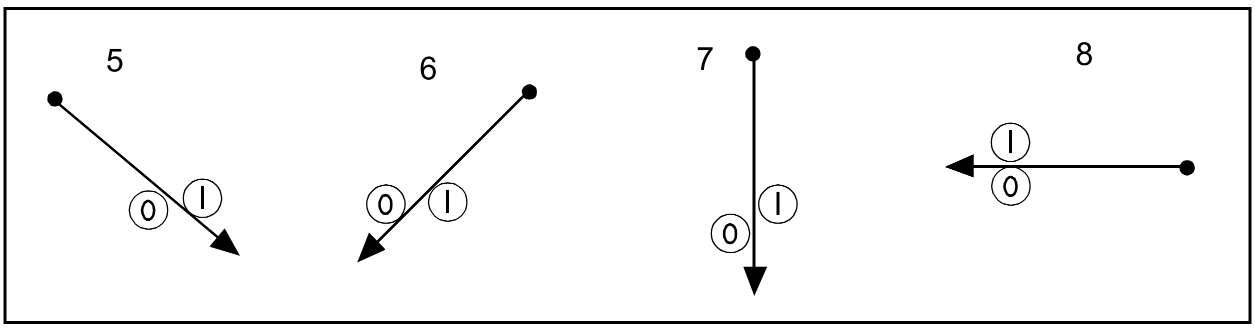
6



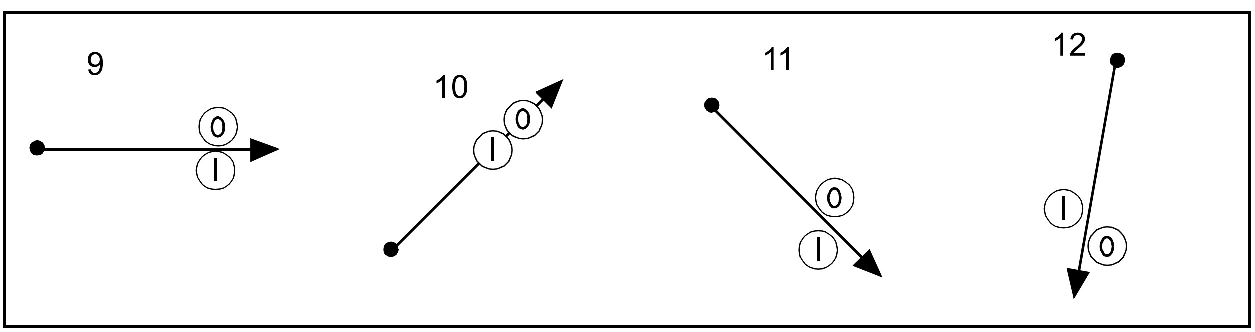
Practice Exercise #2 - Answer Key



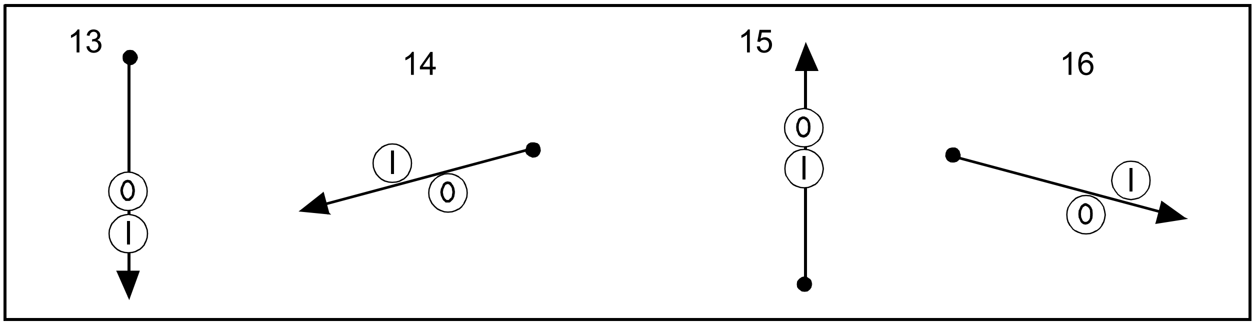
1. _CC__ 2. _CR__ 3. _AC__ 4. _AR__



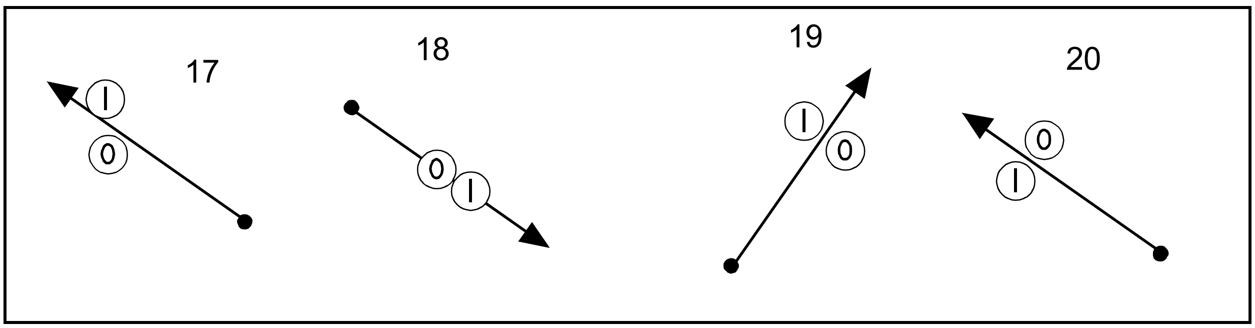
5. _CC__ 6. _CD__ 7. _CD__ 8. _AR__



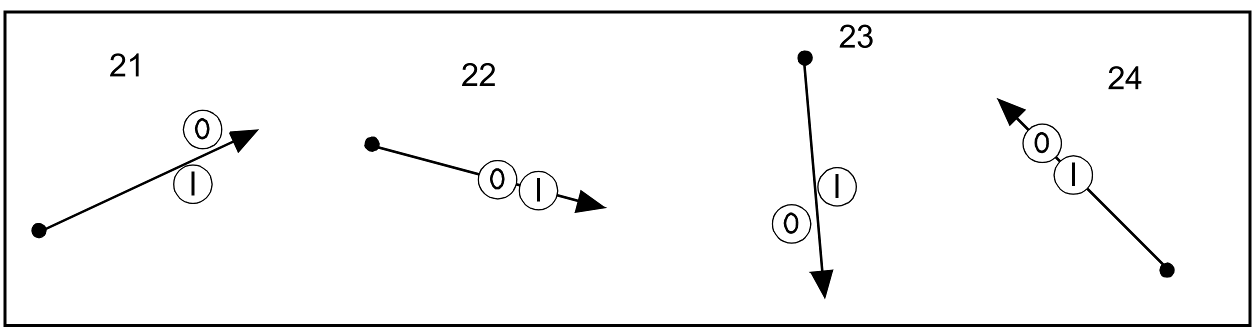
9. _AR__ 10. _PD__ 11. _AC__ 12. _AD__



13. PC 14. AC 15. PD 16. CC



17. AC 18. PC 19. CR 20. CR



21. AD 22. PC 23. CD 24. PD